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MOBILITY ASPECTS OF A SYSTEM DESIGN FOR A DEPLOYABLE RECONNAISSANCE EXTRACTION FACILITY

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Reconnaissance-Intelligence Data Handling Branch
Rome Air Development Center
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Air Force Systems Command
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Air Force, General Design Co., Bedford, Mass. 10/7/65, 105

FOREWORD

The material presented in this report includes a collation of data from instruction and specification documents furnished to the Rome Air Development Center by Craig Systems, Incorporated, as part of contractual obligations under Contract AF 30(602)-3193. The photographic illustrations included herein depict the prototype components as they presently exist.

The concept of deployment and the various complementary techniques evolved toward generation of the design were initially contributed by RADC engineers, who developed the Mobile Wing Reconnaissance Technical Squadron under OSR 406. The concept as presented appears feasible; however, only the accessway shelters discussed have not yet been manufactured to determine their operational capability. Most of the major components are currently being evaluated at RADC and indicate that interface between all components is satisfactory. It is felt that the concept itself, as one operational method, should influence further individual thought toward a practical integration of equipment to achieve better deployment organization. The auxiliary supporting component sections of the report have been detailed only to the extent necessary to provide for clarity in presenting a complete deployment situation.

The deployment plan illustrated in this report was conceived at RADC by engineering personnel of EMIRA on 15 October 1963.

The authors express appreciation to the Mechanical Engineering Section, EMEAM, which is responsible for and provided support in the areas of mobility, air conditioning, power and shelter design.

This technical report has been reviewed and is approved.

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ABSTRACT

This report contains an analysis of factors to be considered in the selection of shelters, power, air conditioning, and transporters relative to efficiency in the attainment of over-all mobility. The evaluations presented herein involved ensuring the best and most timely use of existing technologies. Selection of what was considered to be optimum choices in unit equipments was then integrated to evolve a standard plan for deployment.

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I. INTRODUCTION

Many existing systems today consist of variations in their particular deployment patterns. They consist either of a fixed or flexible configuration, depending on requirements best suited to meet a particular capability. In effect, all land based system designs incorporate or try to incorporate five basic considerations to arrive at an optimum packaging plan. The adopted considerations generally concern themselves with high mobility characteristics, compactness of layout plan (confined area), operational flexibility, modes and means of transportability requirements, and reduced assembly or disassembly relative to time. In defining each of these separately, the following interpretations shall apply:

a. Layout Compactness - refers to relative proximity of all equipments within a certain boundary of real estate. A compact design configuration therefore utilizes the least area per foot of equipment at an operational site.

b. Mobility - refers to the time element necessary in bringing all field components into operation. The less time it takes to assemble within a given theatre of operation, the greater is the mobility index.

c. Operational Flexibility - refers to adapting to specific missions by adding or deleting equipment elements from a system. This characteristic also refers to either utilizing a part of a system capability or its full capability depending on operational demands. It also implies interchangeability of components such as power and environmental control units.

d. Transportability - refers to its adaptability to different modes of transportation; namely, air, truck, rail, and ship. In effect, the total equipment package relative to size and weight must be considered.

e. Assembly and Disassembly - refers to operational configuration set-up time encompassing possible shelter joining techniques, reduction in number of components, cable assemblies, and accessibility of auxiliary elements in relation to their distribution by their functional relationship.

It is felt that the criteria listed above represent the basic ingredients that should be pursued in order to approach a satisfactory system design concept. The design should meet all requirements to attain the capability required. Design concepts should exclude unnecessary features that contribute to overdesign.

A. General System Design

The successful design of system equipment depends on meeting all objectives within a framework of the established design criteria. The criteria involve the establishment of requirements to meet objectives due to immediate needs. Once requirements are established, it is necessary to acquire sufficient information through surveys conducted on applicable existing technologies. Further, after initial design selections are made, alternative designs should be reviewed and the most effective combination of components selected. The final design should then be further examined to see that performance functions meet all requirements. This design is continually reexamined to respond to changing requirements which always occur.

If one is to consider deployment of a system which necessarily includes shelters, power and air conditioning, all of which are interrelated with mobility aspects, it is felt that the following considerations should be given adequate attention for optimization of all deployed elements.

It should be noted at this point that in the category of auxiliary equipment such as just mentioned, costs involved are generally insignificant when compared to the more important costs of electro-optical components involved. However, deploying these components as a package in a selected environment could mean success or failure based on a multitude of considerations that must be applied to meet the desired performance level. In general, then, the ideas and proposed views herein have been established through survey, study and analysis.

Prior to the selection of a shelter to be adopted for field use, the desired physical characteristics required should be established. In most cases today, it is apparent that suitability for operation in any area of the world is essential. This immediately implies four basic considerations; namely, structural design, thermal insulation and air conditioning, power, and general mobility aspects. In order to satisfy these requirements, several investigations must be made. These include a review of existing shelters, analyzing them from a structural and thermal viewpoint and finally selecting power and environmental control with a general investigation toward mobility compliance.

A study was made regarding existing shelters. This study included a survey into air inflatable types, tentage types and more commonly used rigid structure types. Air inflatable types and tentage types do not, in general, meet the deployment requirements of the mobile Reconnaissance Data Extraction Mission. Rigid structures of the Army program were also reviewed and it was generally found that present trends lead to self-contained, self-sufficient units of various sizes. It was also noted that these units, known in the commercial market as heli-huts, are available from several sources. They are also proven elements, having undergone field tests in operational climates.

B. Shelter Size Consideration

At this stage, it is desirable to review size selection knowing that the heli-hut structure offers good strength to weight ratio, good thermal characteristics, good RFI shielding properties, and effective environment protection. In considering a size requirement which in many cases is dictated by the electronic equipment involved, it is felt that all criteria should be critically examined before establishing dimensions. A system flow plan for the entire equipment complex required must be available. Once such a flow plan is generated, it can be subdivided per function or subfunction to any desired degree. This then could determine the number of shelters needed and place a constraint on size. When this is done, however, the following criteria should be emphasized:

1. Weight and bulk of element.
2. Mode of transportation to be used.
3. Means of mobility of the element.
4. Real estate required for deployment.
5. Limitations imposed.

Confronted with a size selection, it is apparent that an optimum size can be defined between the small and large shelter units. Small units can be more easily handled with less packaged equipment and can be transported in greater quantities in a single flight. Large units are less maneuverable for handling with more packaged equipment available and can be transported in limited quantities in a single flight. The prospect of having small units of the 76" x 76" x 96" variety will not be given further consideration because handling requirements and assembly problems get excessive. A floor space of only 50.6 square feet is too confining for personnel activity and equipment. Other obvious reasons, such as increased number of auxiliary equipment necessary to support them, do not allow for system flexibility, especially where human operators must work with the equipment directly. Larger size units, peculiar to standard size modules, such as the Signal Corps S-141( )/G, were examined, not only from an economical viewpoint but from the aspect of their possible favorable contribution for deployment. Increasing the length and over-all size of a shelter, from a present-day known standard, places a large burden on the mobility problem and suggests the following disadvantages.

1. Increased costs by virtue of increased design parameters.
2. Increased weight for an individual package.
3. Maximum height of unit under varying transportation modes may exceed the 132 inches height limitation for international road travel.
4. Transporters not available must be designed to accommodate the larger units.
5. Mobility is limited, requiring more manual assistance for orientation and requiring prime mover of adequate size for towing.

6. Transportation modes restricted to particular aircraft and not capable of being adapted to helicopter lift.
7. Increased difficulties in loading and unloading problems.
8. Decreased aircraft range with increased payload.
9. Size selection restricts number of units that can be transported within an aircraft.

The selection of a size of unit should, in general, accommodate all known modes of transportation and should be dimensionally designed to meet this requirement. The ideal package should fill the available compartment space within payload and loading limitations of an aircraft, considering the maximum range fuel load for the worst condition. It is readily seen that some shelters, therefore, could be up to 40 feet in length. This is impractical when considering basic mobility requirements. To acquire, therefore, a practical size which would fulfill a major portion of mobility requirements, an average compartment length could be subdivided first in one half, then into thirds, fourths, and so on. This, in effect, would establish various sizes possible. Each size would have to be evaluated for its individual merit against general over-all requirements. It can be seen then that an optimum size, once determined, would fully utilize all available loading area of an aircraft. In view of all the thinking that can go into size selection, the S-141( )/G has been an adopted standard for many years due to its versatility as a deployment element. It is adaptable to all modes of transportation and can withstand severe shock and vibration loads consistent with military test specification requirements. A variety of transporters are also available that do not restrict maneuverability to particular types of terrain. It also has the capability of being joined or linked end to end to form a larger enclosure without unduly complicated joining procedures. It is felt that the standard modified S-141( )/G unit is most suitable for many mobile system applications where fixed site conditions are not imposed. A system may consist of one module or a combination of modules dependent on quantitative functional capability requirements.

C. System Deployment

We shall now assume that the system must perform many functions with a large concentration of equipment that must be effectively deployed.

Deployment in any theatre of operation should be reduced to the particular parameters that would influence a high system performance level. The parameters that must be investigated should include the following:

1. Real estate required to deploy.
2. Fixed integrated layout vs. flexible dispersed layout.
3. Fueling system.
4. Set-up time (assembly and disassembly).

5. Ease of field maintenance.
6. Increasing or decreasing number of units employed through minimal effort (modular capability).
7. Over-all mobility and its effect on site layout.
8. Ease of camouflage when required.

It is advantageous in most cases to utilize the least amount of area for a selected system site. Whether located at a well supplied airfield or elsewhere, a closely grouped system complex is economically and functionally sound as well as being technically efficient. Close grouping within a confined perimeter would, in effect, reduce over-all system weight. Reduced requirements in cabling and fuel lines are obvious as well as contributing to more effective coordination between elements or modules. Also, control over personnel responsible for assembly at the site can be more readily established. Support in terms of fueling and accessibility are greatly improved when functionally related elements are within close proximity of each other. The interchange between like equipments can readily take place during component failure possibly keeping the more important functions in service.

A fixed integrated system which utilizes the least area for layout realizes the following advantages:

1. Decreased assembly and disassembly time.
2. Reduced system weight.
3. Shorter and fewer cables.
4. Reduced electronics.
5. Improved reliability.
6. Easier coordination between modules assured.
7. Adaptability to better fueling operations techniques.

In a dispersed system complex, the above advantages are lost whereas in the orderly assembly of equipment, there is much to be gained. A building block or modular technique appears suitable and is a favorable concept lending itself to standardization.

D. Additional Capabilities

In view of the fact that shelters can be joined without losing insulative and shielding qualities, the idea of a modular concept appears more desirable. First, a system should have a growth capability incorporated as a common element to the system. The addition or deletion of elements of the system should be easily accomplished through a minimum of activity. In effect, once a standard modular complex is established, it can be utilized for any electronic system. This one type packaging scheme may be effective in meeting many present day deployment demands. There are many arguments that support the use of the possible modular concept, the most predominant being economics and weight. For example, when two modules are joined in end to end fashion, the amount, size, and type of cables required are greatly reduced.

Investigation has shown that for a particular complex of data processing equipment, a minimum of 680 pounds can be eliminated when two interrelated shelters are joined. Realization of the resulting advantages contributed by interlocking shelters are summarized below:

1. Operational set-up time reduced.
2. Operation more dependable with fewer cables and fewer connectors susceptible to weather. Cables and connectors need not be weatherproof.
3. Less cables exposed to damaging elements.
4. Less chance of misplacing packaged cables.
5. Fewer RF filters and RF shielded connector panels required.
6. Personnel coordination completely fulfilled.
7. Weight and cost savings highly significant.

If it is considered to join more than two shelters, the savings in weight and costs apply, consistent with equipment complexity.

E. Support Equipment Considerations

If modules of the type in question are deployed, it is worthwhile at this point to consider the application of power and environmental control. One argument becomes quite evident when considering the packaging and deployment of these units. This area requires careful consideration from several standpoints in an over-all plan. One aspect of deployment considers total removal of power from the environments, locating the units within the equipment modules. This, in itself, appears to be a sound approach whereby cables, external ducts, and climatic exposure is greatly reduced. It is felt, however, that this type of application has definite disadvantages. Installation of these units within a shelter take up valuable equipment space. Also, costs are increased due to additional structural, vibrational, thermal, sound, and safety features that must be employed. The basic low cost of a standard shelter would increase considerably. There would also be a safety hazard due to internal leakage of fumes and direct introduction of fuel into a module. The vibration and noise problem could become significant if equipment requires isolation from these characteristics. Also, exchanging units due to failure is hampered. These considerations detract from the environmental immunity that could be obtained. Power externally located during operation, but internally stored for transportation, appears more suitable for a system application. Greater interchangeability of components is assured with allowance for growth or future change made possible. If a future change is ever made in selecting power as a result of field-found deficiencies, an external power plan can be easily retrofitted by replacement only. Internal application, however, could possibly mean a significant design change affecting shelters, equipment and associated engineering design parameters.

In any deployed system that must withstand world-wide usage, the extreme temperature requirements, +125°F and -65°F, impose rigid requirements on equipment reliability. In effect, then, if equipment can be properly protected from these direct environments, the detrimental effects can be diminished. Power generation and environmental control equipment, assuming they are external, could be housed in some type of enclosure which becomes attractive when many modules are always deployed together requiring a large supply of power. They could be placed into shelters or can perhaps be contained within plastic field fitted envelopes. This is a secondary approach and involves development and evaluation. Such a technique could be effective in providing a complementary barrier against the elements as well as reducing and directing noise away from sheltered equipment.

Another area that requires consideration is the fuel distribution system, which should be easily packaged, set up, and dismantled. In this area, a study on use of collapsible vs. semirigid and rigid tanks should be pursued. Sizing of fuel tank capacities required for each individual need should be assessed in terms of a standard practical all-around application. Peripheral deployment of fuel and fuel lines due to accessibility and safety inherent in such a layout is recommended.

Logistically, the less parts involved in a closely grouped system, the less manpower and maintenance is required. There appears to be no substitute for a self-contained deployable package which can be readily loaded, transported, and put into operation upon delivery at a site.

In respect to the over-all evaluation of shelters, the investigation made into the Army Quartermaster shelters, Signal Corps shelters and those shelters developed by ERDL did not warrant much consideration. Past and present shelter development programs were reviewed from a deployment standpoint taking into account all criteria necessary for satisfactory performance. In most cases, the weight of ERDL units was not within limits for high mobility application. Their family of shelters was primarily designed for fixed site installation. The air inflatable and fabric type shelters of the Quartermaster Corps, although light in weight, were not considered due to their failure to meet several of the major requirements. For example, the shape of these type elements do not lend themselves to efficient environmental control systems. Shielding aspects and air infiltration problems always exist. Material and fabric stretch and flutter are always present together with excess noise transmission. Geodesic domes and expandable rigid type shelters were also investigated regarding performance in a possible system layout. Each unit taken by itself or in combination, suggested a particular system plan which, when reviewed, did not exhibit many creditable features. For particular isolated applications, each type, however, can probably be used effectively.

F. Summary

The review of all shelters, therefore, terminated in selection of the S-141( )/G shelter as that element most adaptable for system planning. Continued work should be undertaken to further eliminate field congestion due to layout of cable runs, ducts, power, and environmental control packages. Ground level noise within a site area should be eliminated. Perhaps noise-emitting equipment should be elevated above ground level on quick erection type platforms. This would also eliminate equipment from settling at soft, muddy sites. Direct contact with ground snow and water would also be avoided. New ideas should be generated if new systems are to enhance performance operations.

Since techniques for joining shelters have been developed in conjunction with a compatible transporter, a standard deployable system is possible. This standard system, utilizing the basic S-141( )/G and modified as required, possesses these immediate promising features:

1. Easy jointure of modules for compactness.
2. Less use of real estate.
3. Elimination of cabling and duct work, avoiding site congestion.
4. Complete weather protection.
5. Shielding obtainable as required.
6. Transportation modes not restrictive.
7. Effective personnel coordination.
8. Interchangeability and unlimited expansion or contraction capability.
9. Reduced camouflage area requirements.
10. Improved reliability.
11. Reduced system weight.
12. Decreased assembly and disassembly time.
13. Better system fueling technique.
14. Packages completely into aircraft.

As presently deployed in a mobile data extraction system, loading and unloading of power and environmental control units from within equipment shelters by a monorail system, although effective, could be further eliminated. Power and environmental control shelters, as such, could be effectively stationed as self-contained packages ready for immediate use. The hazards due to extreme environments would, therefore, be completely eliminated, bringing all system components under a single packaging plan. When set up in a field, operational status would only demand fuel and electronic interconnection between modules.

Since evaluation has determined that maximum use of an S-141( )/G shelter type for the system plan is most suitable, the following section will concern itself with individual components of equipment. A fully integrated module consists of the following equipment:

a. Shelter S-141( )/G (modified)
b. Transport dolly
c. Load handling device (monorail system)
d. Gas turbine generator set
e. Environmental control unit

Essentially, these items will be discussed in sufficient detail to present the aspects of equipment loading, transporter requirements, and shelter joining techniques which finally contribute to evolution of a concept that provides for easier shelter orientation adaptable for system deployment. It has also been established that a fixed configuration will be specifically utilized in an operational plan that offers an orderly set-up sequence.

II SHELTER S-141( )/G (MODIFIED)

A. General Description, Characteristics

Basically, the selected shelter type, S-141( )/G per MIL-S-52059, has been modified to accommodate particular electro-optical equipment layouts. These layouts should be tailored to the individual shelter and should minimize the modifications required. This is desirable from an economic viewpoint as well as the possible shorter lead times that may be gained from basic availability.

The shelter, as illustrated in Figure 1 has the following physical characteristics:

	Inside	Outside (over protrusions)
Length	132"	142"
Width	76"	81"
Height	76"	85"
Weight		1200 lbs.

The weight as indicated does not include raceways, receptacles, power and communication entry panels, RFI, filters, etc. This basic unit weight is derived from the general construction technique which provides a high strength to weight ratio. The shelter walls, flooring and ceiling are made of 2-inch thick lightweight sandwich fabrication consisting of 0.032-inch thick aluminum facings enclosing a polyurethane plastic foam core. The core densities vary from 4 to 8 pounds per cubic foot with the higher densities used in the floor to increase load carrying capacities. The core itself provides for good insulating qualities contributing to a 0.3 BTU per square foot

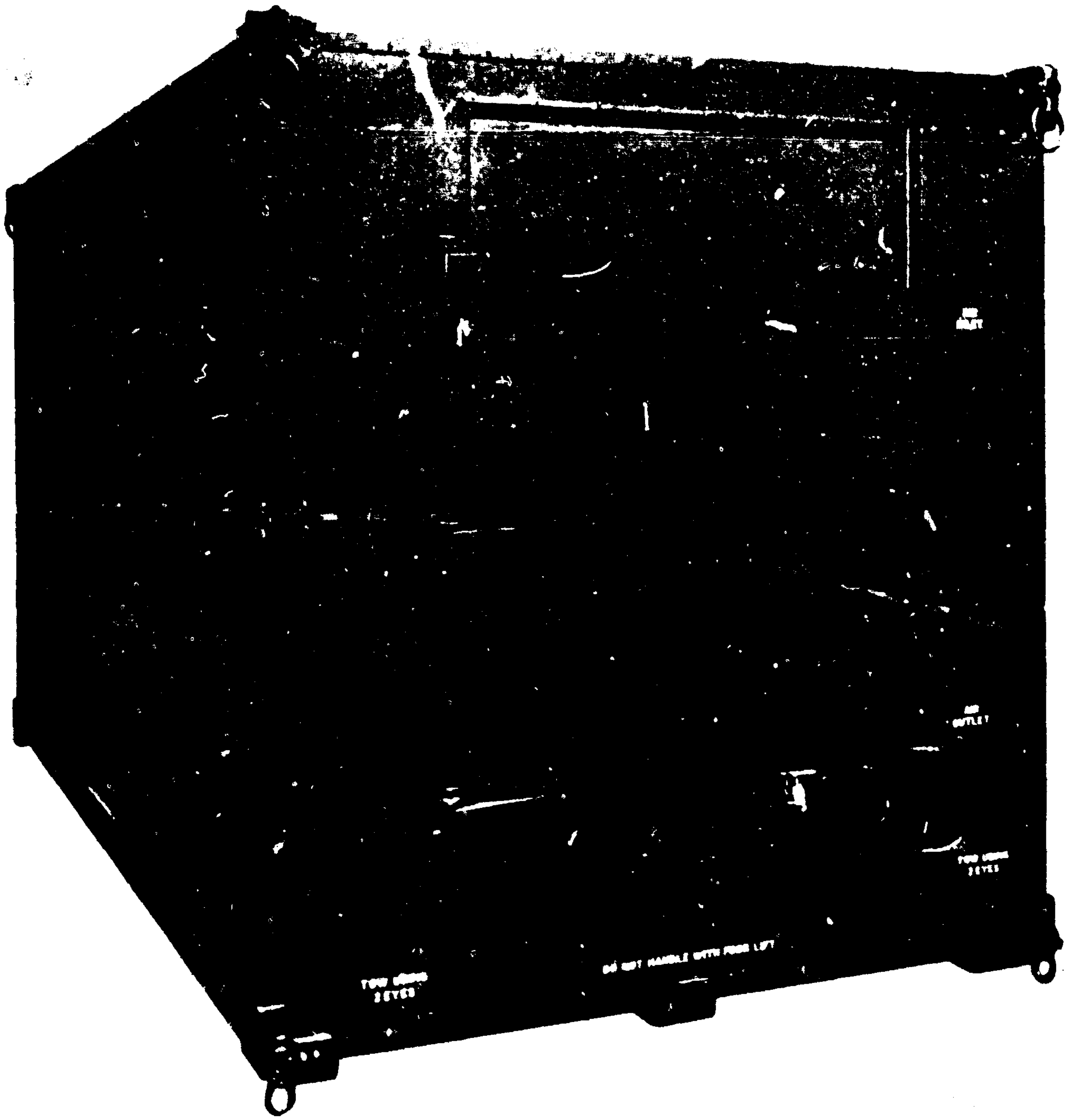

Figure 1. Shelter S-141( )/G Modified

per hour per ^{O}F. over-all coefficient of heat transfer for a shelter panel. The shelter structure is capable of containing payloads of up to approximately 5000 pounds. The module is air-tight to the extent that an air pressure of not less than one half inch of water is developed when air is forced from the outside with all openings closed. Three skids are mounted longitudinally on the undersurface of the shelter. These skids permit the shelter to be towed for limited distances over rough terrain, snow and ice without causing damage to any part of the shelter. The shelter floor contains a drain and plug and is surfaced with a nonskid material. Towing eyes are provided on each end of the shelter together with four lifting eyes, one at each upper corner, for hoisting and tie-down. Each lifting eye has a minimum ultimate strength of 11,000 pounds. Definitive design parameters are listed in MIL-S-52059; however some of the basic characteristics are as follows:

1. Transportable by air, ship, rail, and truck.
2. Meets world-wide environmental requirements.
3. Floor loading 150 lbs/sq. ft.
4. Over-all U factor, 0.30 BTU/sq ft/hr/^{o}F.

B. Adaptability to Modifications

The S-141( )/G is adaptable to modifications as desired. Cutouts, panel entry boxes, and environmental control openings may be located where required. The shelter can also be provided with removable end panels, both to facilitate installation and provide ample access for equipment overhaul. These shelters may also be provisioned to accept fork lifting if that capability is essential. Generally, the unit can be altered to meet individual needs while still maintaining its structural integrity. A family of various shelter sizes using the basic S-141( )/G characteristics are available and have been used for different military applications.

C. Joining Shelters End to End

The joining of shelters between related functional units appeared to possess enough merit to warrant such a union. It is a practical solution whereby high density interconnecting cabling problems can be significantly reduced. Also, where a continual transfer of physical data and personnel are required between units, joined modules eliminate operation under adverse environmental conditions. Two methods of jointure were considered:

a. Direct jointure end to end
b. Extended or spaced jointure

Both of these methods as proposed are illustrated in Figure 2. Direct jointure refers to intimate end wall contact of shelters whereas spaced jointure refers to the placement of shelters within close proximity of each other and providing a closed link with use of additional rigid or flexible material.

In using the technique of direct jointure, shelters delivered to an operating site would merely be closely positioned end to end. End panels would be unbolted and items stored for transit could be easily removed from the shelter. The removable panels could then be stored on the roof or sides of deployed shelters. With all movable auxiliary items removed, the shelter would be easier to orient for final positioning. By physically pushing the shelter on large pneumatic tired wheels, the shelters could be positioned close enough to engage corner eye bolts. Alignment and leveling would then

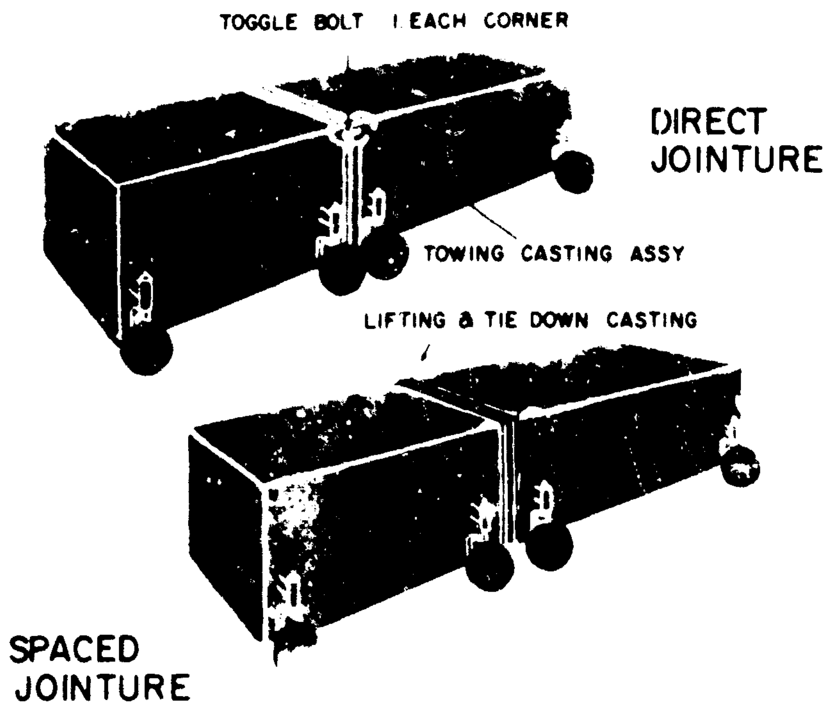

Figure 2. Direct and Spaced Jointure

be accomplished by adjusting relative jack heights. Side alignment would further be accomplished by guiding the shelters sideways as they are pushed together. An engagement of swing bolts at the corners will complete the joining of the shelters. The joining of shelters has previously been accomplished, although it is felt that the techniques can be greatly improved with the use of a combined jack and caster transporter assembly. Figure 3 illustrate an actual union between two shelters. Figure 4 shows the locking means through use of corner swing bolts after positioning.

There are numerous advantages derived by joining equipment shelters, especially in designs where equipment demands a large amount of interconnecting cables.

A few advantages supporting direct jointure of shelters are as follows:

1. Faster set-up time to become operational.
2. More dependable operation with more cables inside the shelters and fewer cable connectors.

In addition, these cables and connectors would not be exposed to outside damaging elements of weather, running over cables, lost or misplaced cables, etc.

Figure 3. Joined Shelters

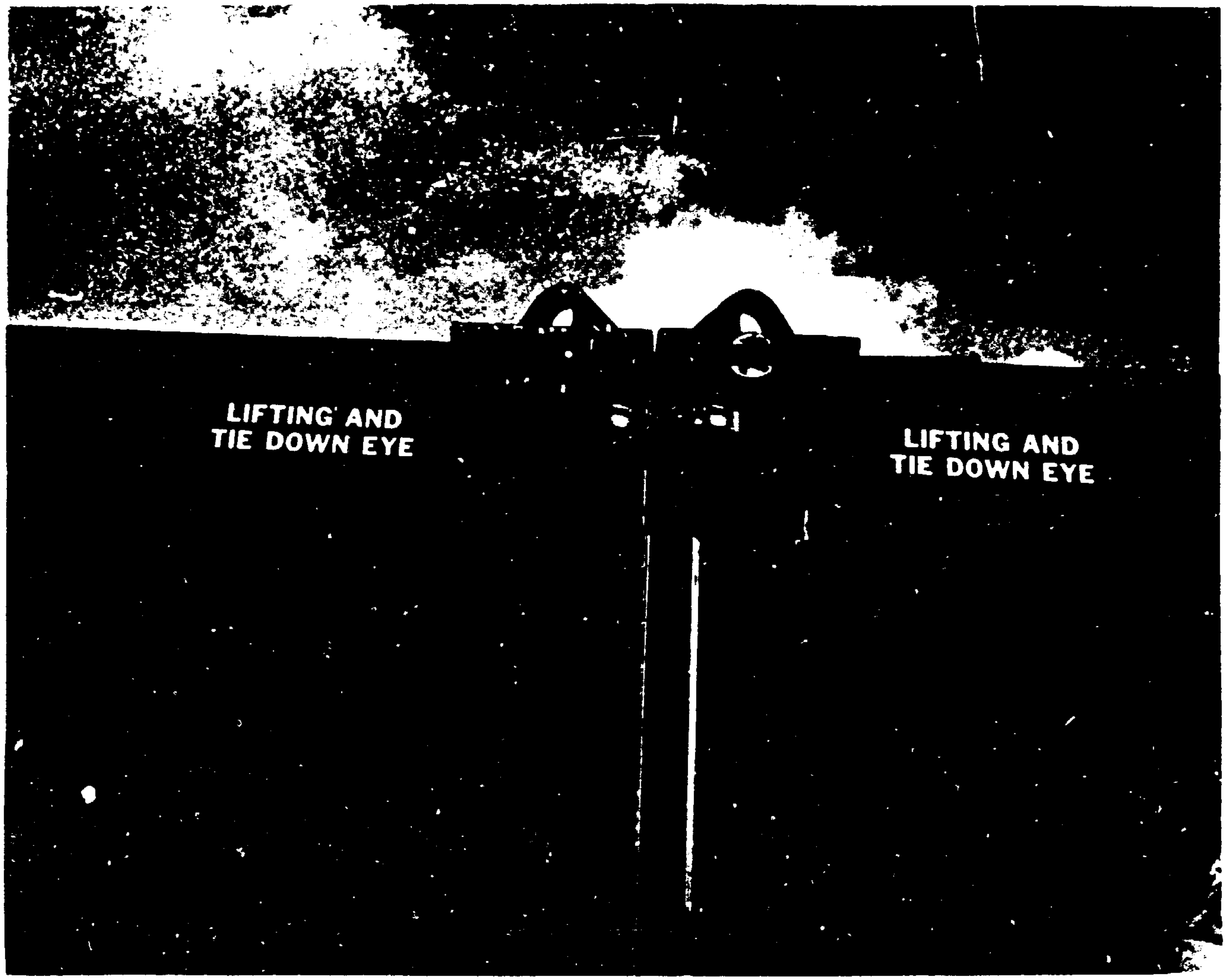

Figure 4. Corner Swing Bolts

3. Weatherproofing of these cables would not be required.

4. Since the joined units would still possess their RF shielding qualities, there would be fewer RF filters and RF connector panels required. There would be considerable savings in weight and cost dependent on type of equipment involved.

5. Shelter joining approach is not limited to two shelters; more than two could be joined, if desired. When field erecting these shelters with inclement conditions prevailing, protective curtains would be used over exposed interiors.

In the extended or spaced jointure as illustrated in Figure 2, shelters are brought together within a few feet of each other and joined by interposing rigid panels or flexible fabrics. The connected shelters are thus joined by an enclosed passageway permitting entrance from one to the other exclusive of the environment. The spaced joining and direct union technique offers possibilities that may be adapted to integrate a standard deployable system concept.

In view of the foregoing discussion on joining techniques, a transporter with essential complementary features must be available. The development of a transporter was therefore undertaken to supply the means of omnidirectional movement with built-in leveling features.

D. Transportability

1. Transport Dolly

The Limited War Intelligence Reduction Complex basically involved an air-transportable system consisting of shelters which had to possess the capability of being readily moved about within a selected operational area. Since the operation and set-up of the system involved joining certain shelters end to end and others within close proximity to each other to form a compact deployable system such as shown in the frontispiece, it became apparent that a reliable and rugged set of wheels were required. Many of the present day military type demountable wheels available do not possess all the characteristics desired. Essentially, most of the known transporters are attached to the end walls of shelters and have limited turning radii. There are also some that are attached at the corners and are secured beneath the shelter. Since the established deployment plan in part required end wall to end wall union as well as a close packaging technique, the system required a Type II, Group C mobile transporter which would permit shelter assemblages to be moved for short distances over improved terrain, such as alongside runways and similar environments to be found near and at air fields throughout the world. Precise positioning of the payloads requiring capability of 360-degree lateral movement was given prime consideration. Development of such a transporter was therefore pursued and accomplished. The technical characteristics are described in the appendix. It should be noted that mobility restraints were limited to 10 mph travel on unpaved secondary roads and 20 mph on paved strips.* In operation, the design payloads and transporter can be towed by vehicle or manually moved by personnel.

2. Concept of Operation

a. General

In order to provide a transporter embracing the functional capabilities required, it was determined that a jack and caster assembly with necessary mounting hardware would be most practical. Mounting hardware would be needed to adapt it to an S-141( )/G shelter. Minor variations in design of the adapter plates would easily allow for universal use of such a transporter. Four each assemblies, as illustrated in Figure 6, would be required per shelter and each assembly would be individually mounted at the sidewall corner panels. Interference from the wheel assemblies on the end walls was eliminated, thus allowing for end wall interconnection when desired. Figure 5 illustrates the normal type of end wall attachment using present day wheel designs. Removable end panels, when required, would not now have accessibility problems. The four mounted assemblies thus provide a means of complete precise flexibility of motion when moving over improved terrains. This concept of integrating the jack and caster assembly eliminates the necessity of any auxiliary shelter handling equipment in order to achieve omnidirectional mobility. It is estimated that two men can install the four jack and caster assemblies on a shelter in 30 minutes. This includes raising the shelter to its maximum traveling position. Clearance under the shelter skids with shelter at maximum height is 12 3/4 inches. When towed by means of a powered vehicle, the transporter tracks properly without use of a steering linkage. Normally, the front wheels are free to swivel and the rear wheels are locked in straight ahead. The transporter utilizes 360 degrees swiveling pneumatic tired caster wheels which are also equipped with a four-position 90 degree locking means. The wheel supporting strut consists of an aluminum tube designed to function as a jack which provides for leveling of the shelter. This is accomplished manually by a ratchet handle to activate a gear drive which is a part of the jack strut housing assembly. The assembly itself has an inboard and outboard position. In the inboard or closed position, Figure 7, the over-all width of the transporter attached to an 80 inch wide package is 114 1/2 inches which allows for C-130 aircraft loading. In the extended or outboard position, Figure 7A, the transporter over-all width on an 80 inch wide package is 124 inches. The transporter provides for Type II, Group C mobility performance per MIL-M-8090. Each jack strut assembly weighs

*Highway use is prohibited due to the 120 inch width of the system in the road transport condition.

Figure 5. General Transporter Attached To Shelter

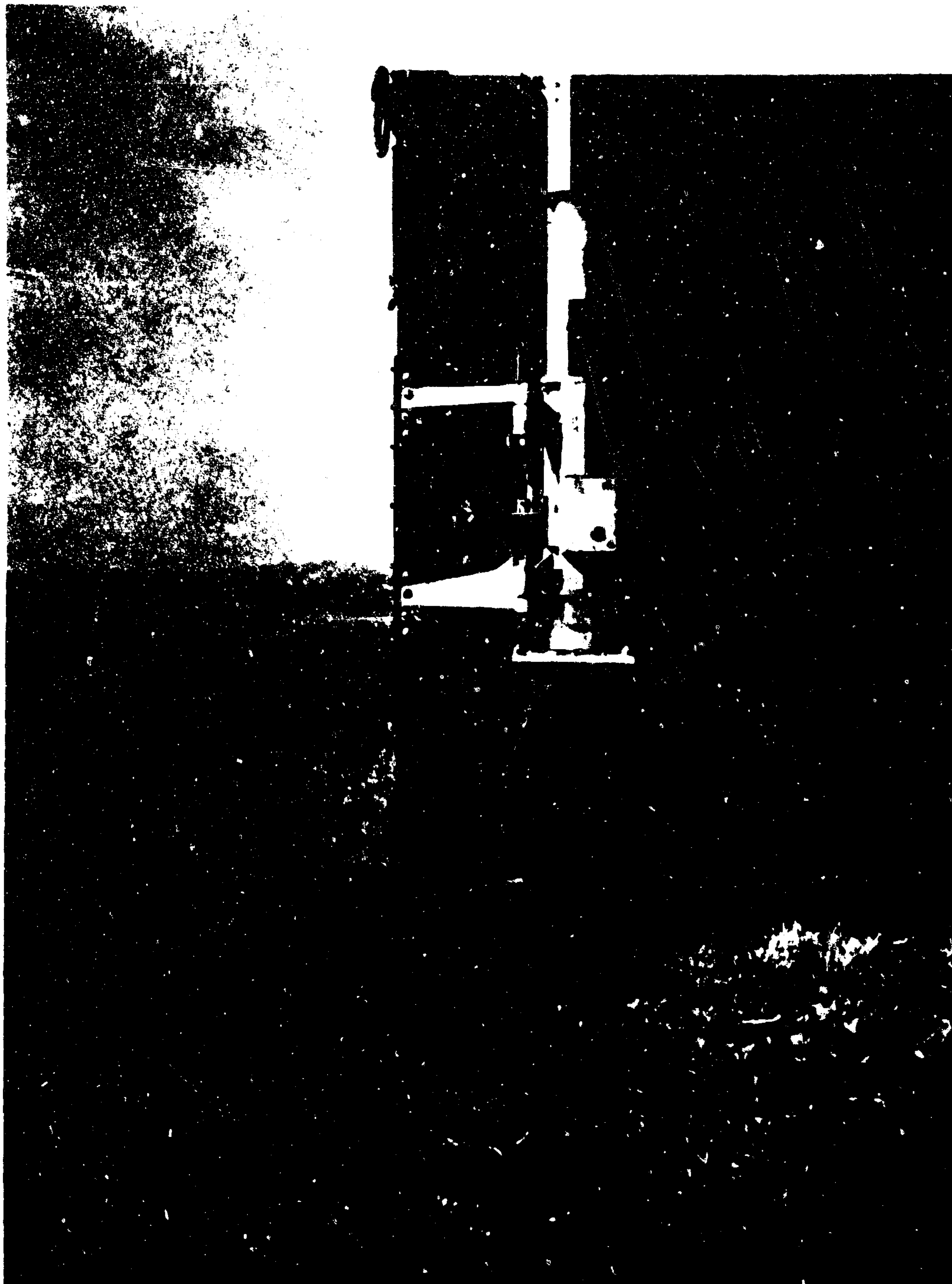

Figure 6. Jack and Caster Type Transporter

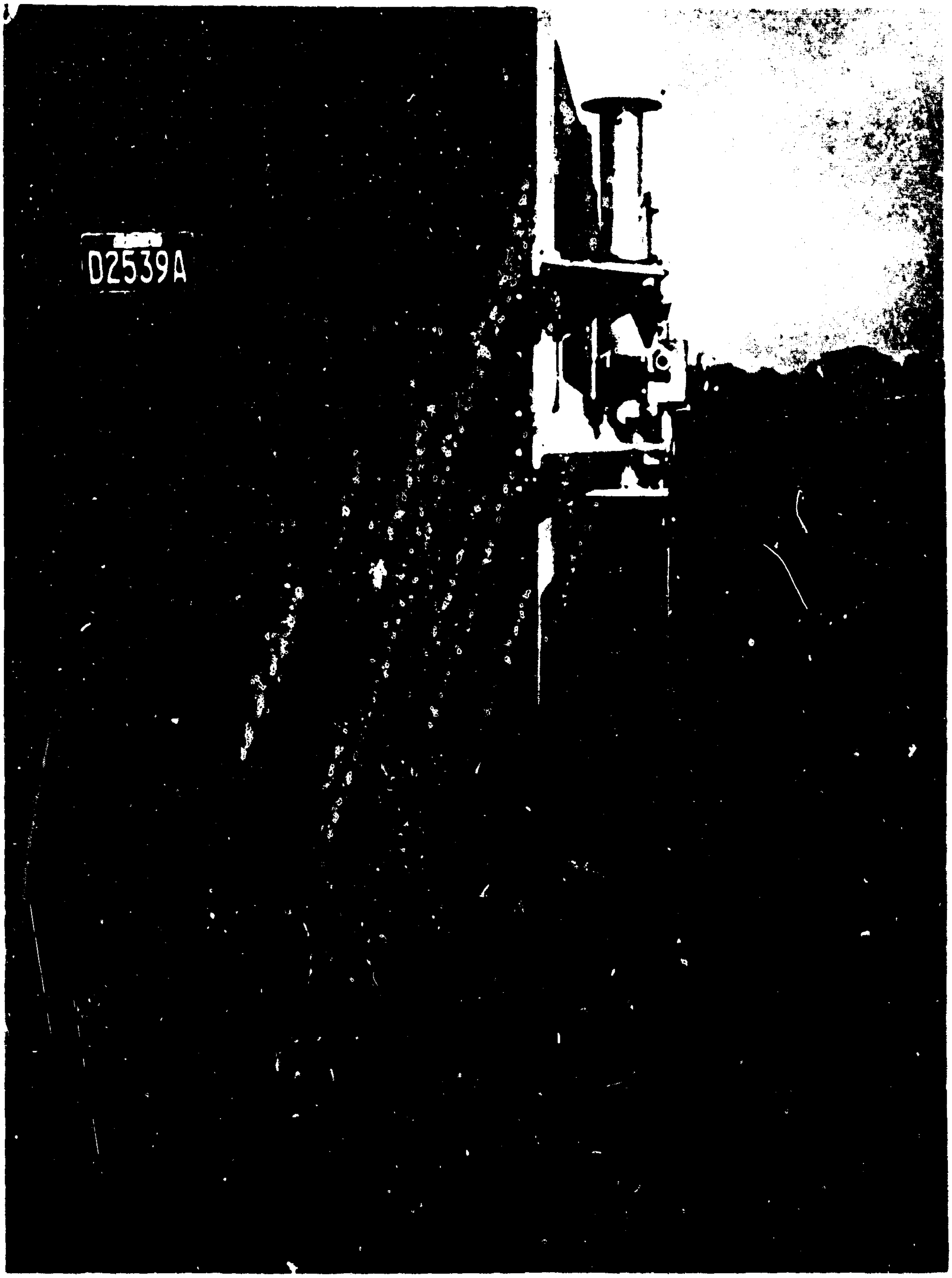

Figure 7. Transporter (Inboard Position)

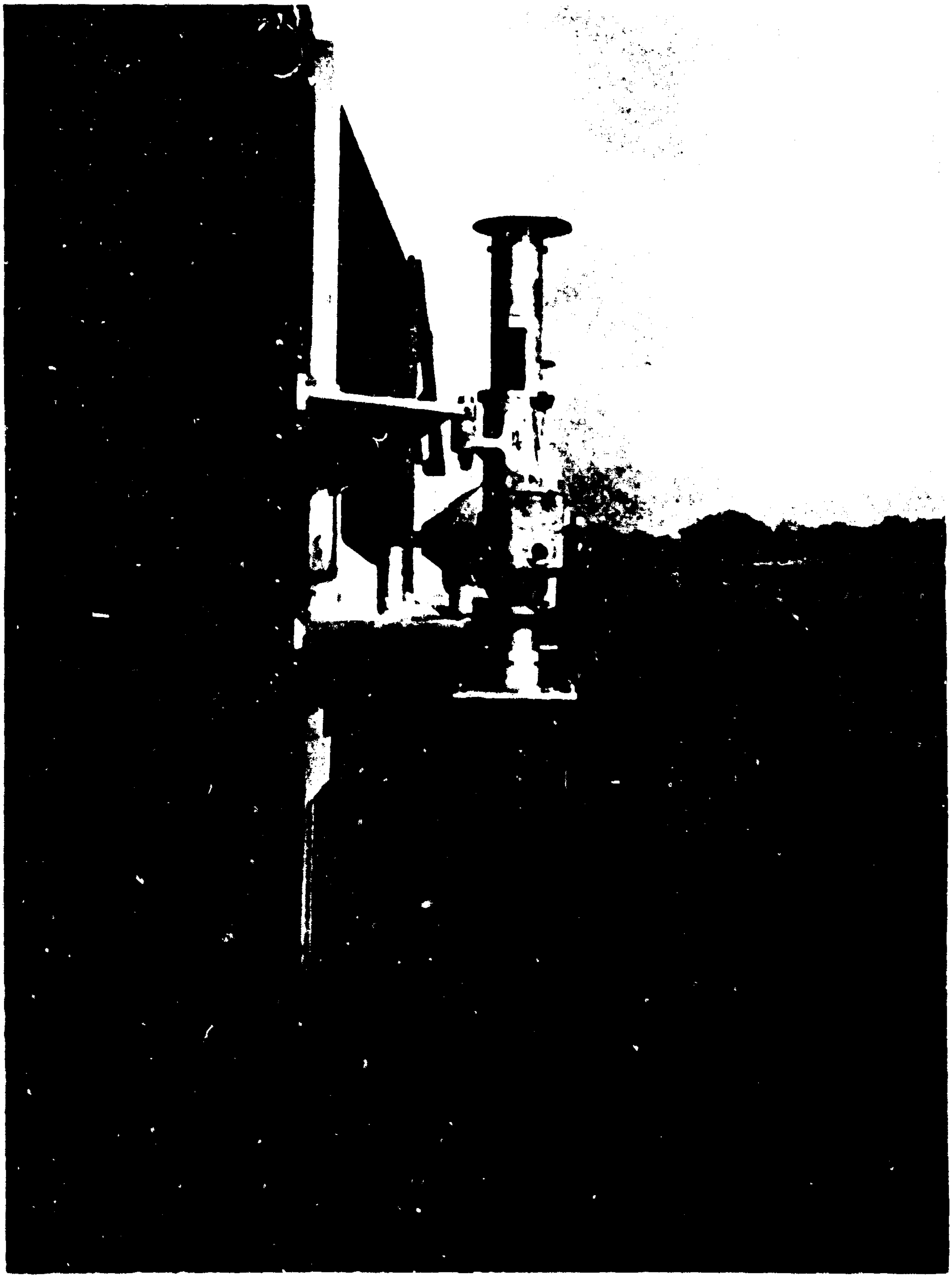

Figure 7A. Transporter (Outboard Position)

216 pounds and requires two men to mount each jack strut to the payload. Tires are pneumatic 6:00 X 9:00, 6-ply, conforming to Federal Specification 22-T-381 and are pressurized to 65 psi. The tires may be deflated to lower pressure to assure greater shock absorption. The transporter uses the shelter as a chassis and is adaptable without modification to different shelters as well as other payloads by means of adapter brackets. Present design payload is 5500 pounds. The adapter brackets must be custom-designed for the individual application. The transporter units bolt directly to each sidewall corner of an S-141 type shelter to which is added the adapter brackets and a stiffening channel. The method of attachment is with an ordinary mechanic's wrench. The over-all intended use of the transporter is to provide mobility to S-141 shelters for world-wide military use including loading of the shelter onto a C-130 aircraft for transport with transporter attached. This transporter, when mounted on S-141 shelters, meets clearance requirements of a C-130 aircraft including negotiation of the ramp without special tools or additional parts.

b. Aircraft Loading

Loading of the shelter assemblage has been worked out for a C-130 aircraft as depicted in Figures 11 and 12. In the over-all study in preparing the entire concept presented, aircraft design characteristics were reviewed and the data was condensed into a convenient chart as shown in Table I.

c. Advantages

The transporter depicted herein has many distinct advantages when placed in operational use where precise maneuverability is of prime consideration. In joining shelters end to end, whether through direct jointure or through interconnecting means, the following advantages are presented.

The increased operating features of this transporter are numerous and are as follows:

1. Provides a means of moving and aligning shelters for end to end joining.
2. Provides for sideways positioning of shelters.
3. Provides leveling for each individual wheel.
4. Provides 360 degree swivel wheels with locking capability at 90 degree intervals. (Figure 8)
5. Provides simplified steering without linkage.
6. Provides positive directional control during backup.
7. Provides for rapid removal of assemblies.
8. Provides for lowering the shelter onto the deck of the transporting aircraft for tie-down.

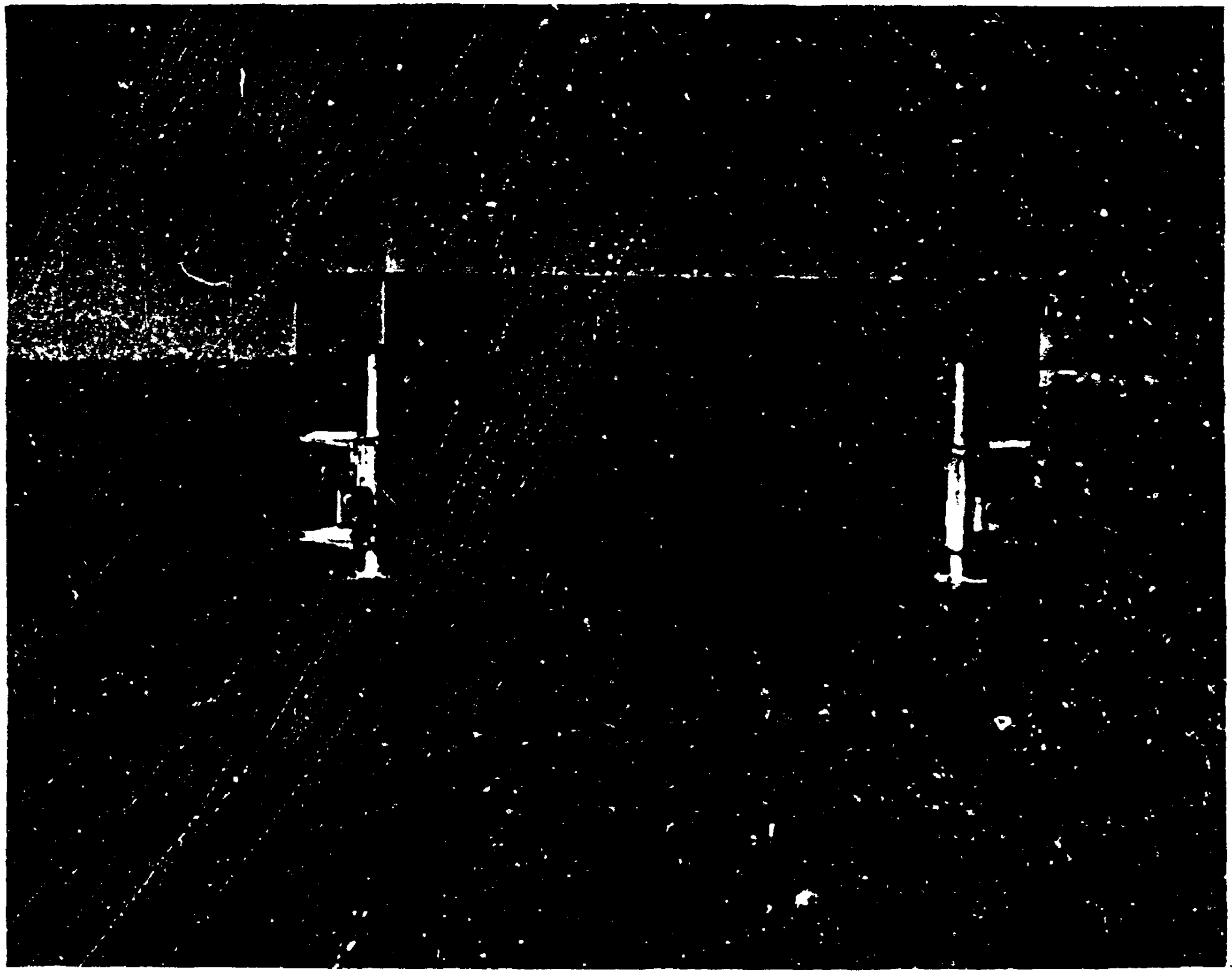

Figure 8. Transporter (90° Orientation

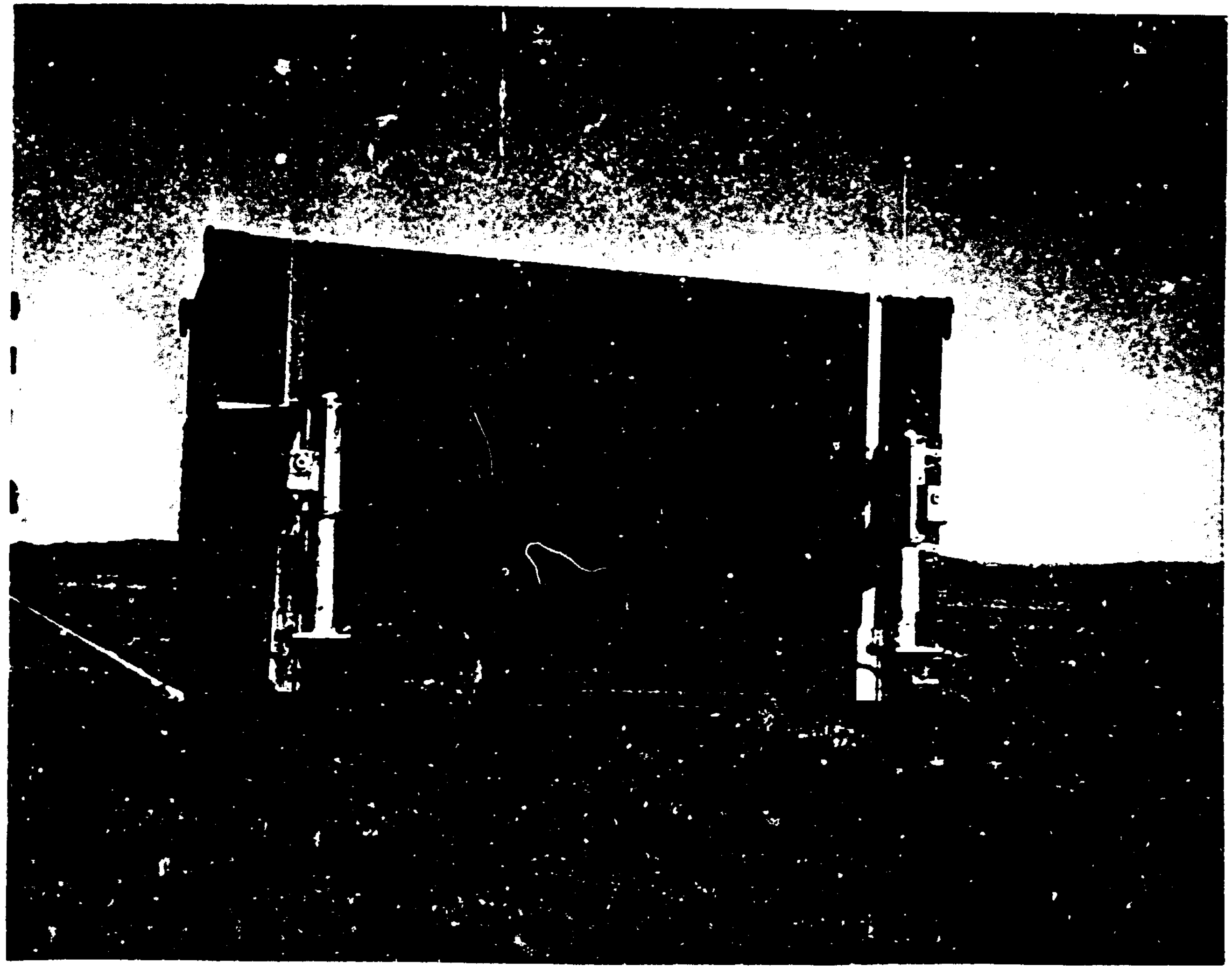

Figure 9. Transporter With Wheels In Towing Position

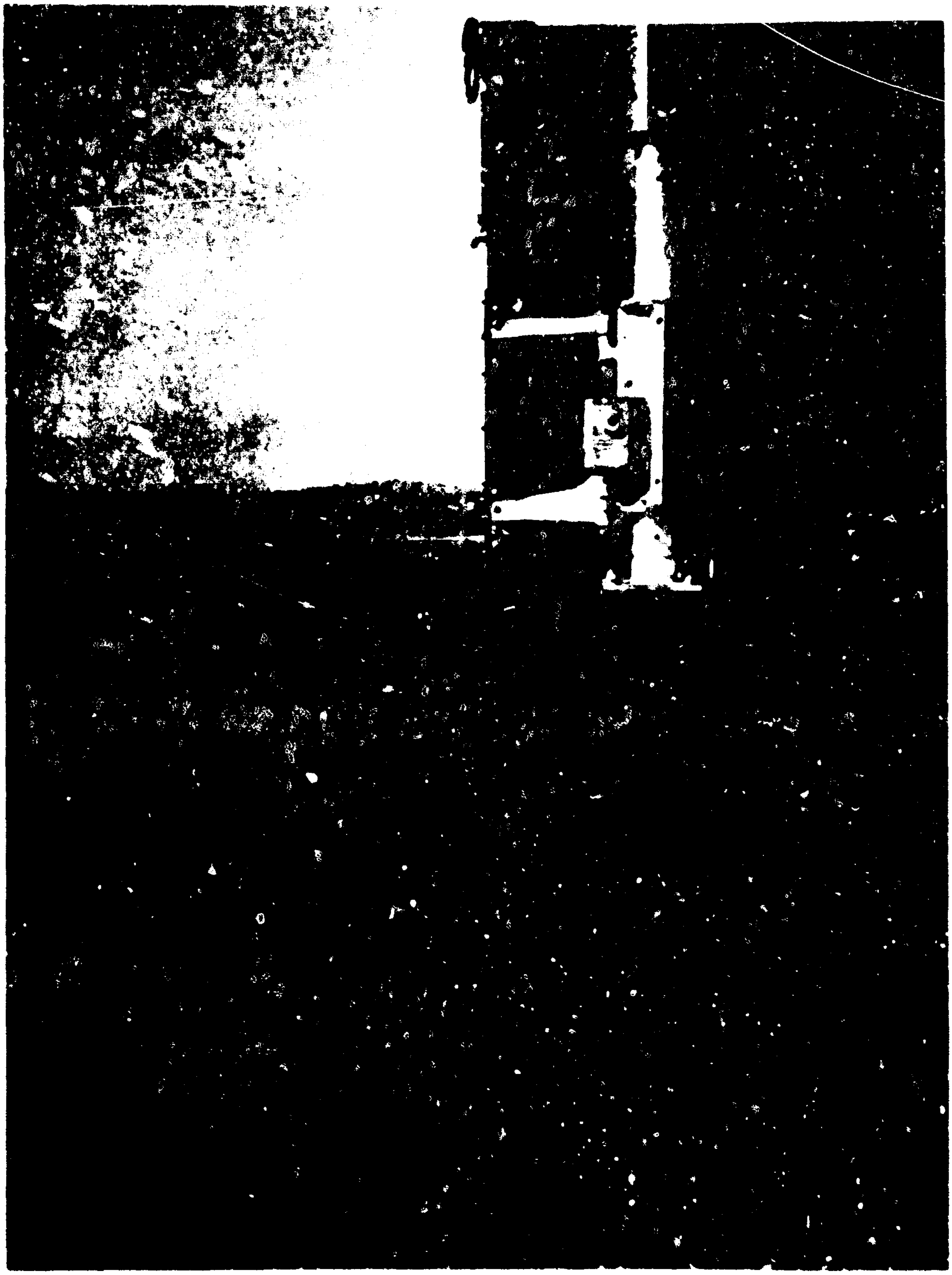

Figure 10. Transporter W'th Wheel In Outboard Raised Position

TABLE I

FIXED WING CARGO AIRCRAFT CHARACTERISTICS

	C-119				C-123B	C-124		C-130A
	B	C	F	G		A	C	
MAXIMUM PAYLOAD (lbs.)	25,000	28,000	33,000	29,000	23,000	75,946	76,486	35,000
LOADING DOORS TYPE & LOCATION	RAMP AFT	SAME	SAME	SAME	RAMP AFT	NOSE LOADING WITH RAMP & ELEVATOR		RAMP AFT
DOOR DIMENSION HEIGHT WIDTH HEIGHT FROM GROUND	8.0' 9.2' 4.0'	SAME	SAME	SAME	8.2' 9.2' 2.6'	11.6' 11.3' 8.3'		9.2' 10.0' 3.4'
CARGO COMPARTMENT HEIGHT WIDTH LENGTH	8.0' MAX 7.9' MIN 9.8' MAX 9.1' MIN 36.9'	SAME	SAME	SAME	8.2' 9.2' 36.7'	11.6' 11.3' 77.0'		9.1' 10.3' 41.4'
TYPICAL ITEMS OR LOADS	Vehicles Personnel Pallets Bulk Cargo	SAME	SAME	SAME	Vehicles Personnel Pallets Bulk Cargo Structures	Vehicles Personnel Pallets Bulk Cargo Structures	Vehicles Personnel Pallets Bulk Cargo Structures	Vehicles Personnel Pallets Bulk Cargo Structures
CRUISE ALTITUDE (FT.)	5000	5000	5000	5000	5000	5,000 To 10,000	5000	27,900 To 42,000
RANGE (N. Mi.) RADIUS (N. Mi.) PAYLOAD (lbs.)	1450 750 14,300	1420 750 16,200	1462 750 20,650	1391 750 20,600	1333 688 16,000	1792 1000 62,880	1700 1000 68,000	2450 1000 29,000
RANGE WITH MAX. PAYLOAD	200 N. Mi. 25,000 lbs.	100 N. Mi. 28,000 lbs.	200 N. Mi. 32,000 lbs.	200 N. Mi. 29,000 lbs.	200 N. Mi. 23,000 lbs.	1000 N. Mi. 75,446 lbs.	1000 N. Mi. 76,486 lbs.	1650 N. Mi. 38,000 lbs.

FIXED WING CARGO AIRCRAFT CHARACTERISTICS

	C-133A	C-118	C-74	C-47				
MAXIMUM PAYLOAD (lbs.)	116,287	41,000	65,000	13,000				
LOADING DOORS TYPE & LOCATION	RAMP AFT	FWD. & AFT NO RAMP	MAIN DOOR LEFT PLATFORM AFT TRAVELING CRANE	LEFT AFT				
DOOR DIMENSIONS HEIGHT WIDTH HEIGHT FROM GROUND	12.5' 12.2' 4.2'	Main door(aft) H 10.3', W 6.5' Ht. fr. Gnd 3.9' Fwd door H 7.6', W 5.6' Ht. fr. Gnd 8.8' Lower doors H 3.8', W 3.1'	Main door H=10' W=10.4' Ht. fr. Gnd 11.9' Loading Well L=12.9' W=7.1'	5.9' MAX 4.6' MIN 7.0' 4.7'				
CARGO COMPARTMENT HEIGHT WIDTH LENGTH	13.3' 11.8' 95.7'	AFT H=10.4' W=6.6' FWD H=7.6' W=5.6'	8.3' 11.1' 74.4'	6.4' 7.4' 30.1'				
TYPICAL ITEMS OR LOADS	Vehicles Personnel Pallets Bulk Cargo Structures Missiles	Cargo Personnel Bulk Cargo Litters	Vehicles Personnel Pallets Bulk Cargo Litters	Engines Personnel Parapacks Bulk Cargo Litters				
CRUISE ALTITUDE (FT.)	14,000 Speed - 259	10,000	5000	5000				
RANGE (N. Mi.) RADIUS (N. Mi.) PAYLOAD (lbs.)	4000 2000	1705 1000 34,663	1825 1000 48,147	1026 500 9,485				
RANGE WITH MAX. PAYLOAD	2000	1900 N. Mi. 41,000 lbs.	500 N. Mi. 65,000 lbs.	100 N. Mi. 13,000 lbs.				

ROTARY WING CARGO AIRCRAFT CHARACTERISTICS

	(USAF H-19)		ARMY	(USAF H-21)		ARMY	ARMY	ARMY
	A	B	D	A	B	C	H-34A	H-37A
MAXIMUM PAYLOAD (lbs)	2100 int. 2000 ext.	1750 int. 2000 ext.	1600 int. 2000 ext.	5500 int. 5000 ext.	5500 int. 5000 ext.	5500 int. 5000 ext.	3211 int. 5000 ext.	6000 to 10,000 6000 ext.
LOADING DOORS TYPE & LOCATION	SLIDING RIGHT SIDE	SAME	SAME	SLIDING LEFT SIDE	SAME	SAME	SLIDING RIGHT SIDE	CLAM SHELL FWD. LOADING RAMP
DOOR DIMENSIONS HEIGHT WIDTH HEIGHT FROM GROUND	4.0' 4.0' - -	SAME	SAME	5.0' 3.8' 3.1'	SAME	SAME	4.0' 4.3' 2.8'	3.8' 7.3'
CARGO COMPARTMENT HEIGHT WIDTH LENGTH	6.0' 5.5' 10.0'	SAME	SAME	5.5' 5.6' 20.0'	5.2' 5.7' 21.3'	5.2' 5.7' 21.3'	5.8' 5.0' 13.4'	6.7' 7.3' 30.1'
TYPICAL ITEMS OR LOADS	Personnel Litters Bulk Cargo Sling for Ext. Cargo	SAME	SAME	Personnel Litters Bulk Cargo Sling for Ext. Cargo	SAME	SAME	Personnel Litters Bulk Cargo Sling for Ext. Cargo	Personnel Litters Bulk Cargo Vehicles Pallets
CRUISE ALTITUDE (FT.)	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
RANGE (N. Mi.) RADIUS (N. Mi.) PAYLOAD (lbs.)	 164 1110	60 22 1750	219 110 1600	233 135 3787	239 134 3132	239 134 3268	239 131 3211	200 105 4442
RANGE WITH MAX. PAYLOAD	296 N. Mi. 1650 lbs.	60 N. Mi. 1750 lbs	219 N. Mi. 3787 lbs.	233 N. Mi. 3787 lbs.	202 N. Mi. 3914 lbs.	167 N. Mi. 4186 lbs.	239 N. Mi. 3211 lbs.	120 N. Mi. 6334 lbs.

9. Provides for improved logistics with less spare parts as compared to other transporters.

In examining the above noted advantages, it can be seen that shelter maneuverability is unlimited when aligning units in either the vertical or the lateral plane. Thus, shelters when set up in a raised condition allow for cables to be run beneath shelters reducing cable lengths and maintaining clearer areas. Rapid removal of wheel assemblies also allows shelters to be transported by M-35 trucks for more rapid and further movement to other desired locations. Figure 8, Figure 9 and Figure 10 illustrate wheels positioned in different positions.

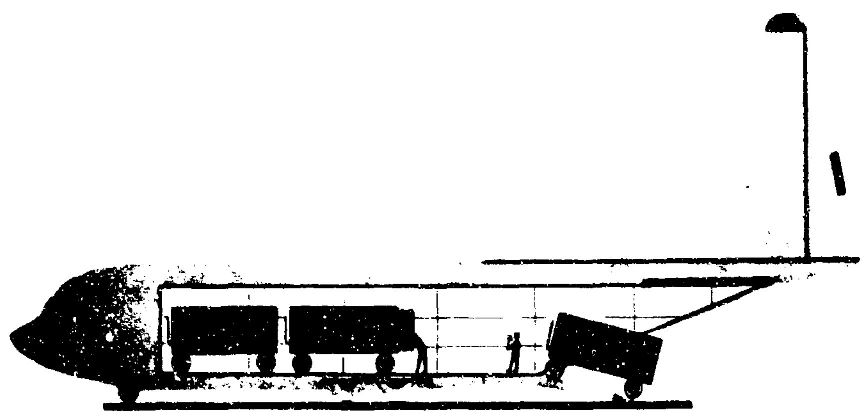

Figure 11. Aircraft Loading Sketch (C-130 Aircraft)

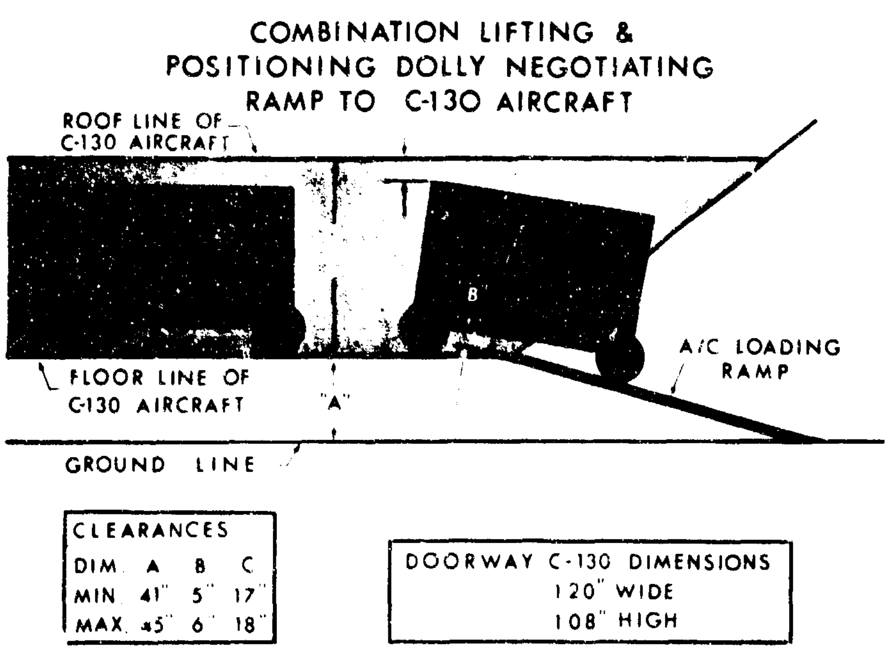

Figure 12. Aircraft Loading Limitations

E. Monorail System (Load Handling)

1. Description and Use

During transport, both the environmental control unit and power generator will be stored within the shelters in the aisle area and must be removed from the shelters during operation. Inasmuch as the environmental controller weighs 275 pounds and the generator 400 pounds, a simple, rapid method of removing these two components must be provided. The method recommended to effectively accomplish the task of lifting and lowering the loads within the shelters is illustrated in Figure 13.

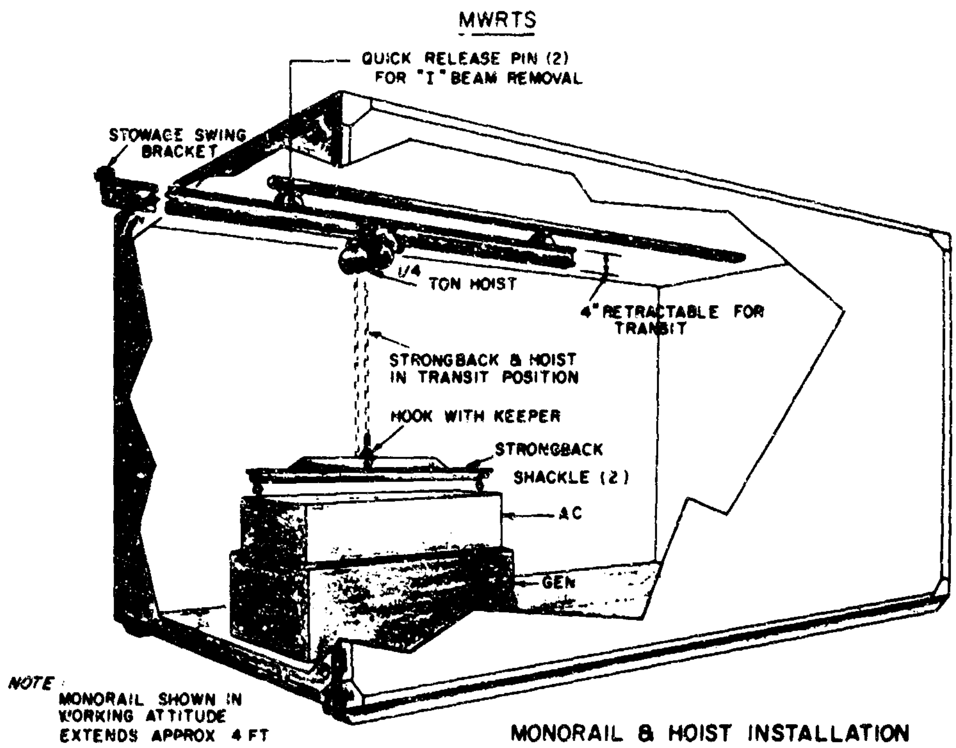

Figure 13. Load Handling Illustration

Essentially, the technique consists of an overhead monorail lifting device which is stored for transit after loading. Due to space limitations that will inevitably exist, the environmental controller will store on top of the generator. Hold-down will be by means of straps with self-tensioning buckles attached to corner brackets attached to the floor, matching the four bottom corners of the generator. These brackets will be removable by hand-operable toggle bolts. The brackets will provide restraint for horizontal shear forces. The straps will hold the items down. Shear pins in the top of the generator fitting matching pockets in the base of the environmental controller will provide restraint for horizontal shear forces on the environmental control unit. Strap buckles will be located so that tensioning of straps will be accomplished from the front or top of the units near the doorway. Personnel would not be required to climb on top of the units or get behind them, as the overhead monorail loading device will facilitate placement of the units in the storage position. The illustrated monorail loading device is designed for use where strength and lightweight features can be used to advantage with respect to loading and unloading heavy equipment into and out of shelters with a minimum of military personnel. The monorail will be capable of supporting 500 pounds. The device is constructed of lightweight, high-strength aluminum and consists primarily of an aluminum I-beam, a trolley assembly, a hand operated 1/4 ton hoist, and a fixed ceiling track. The monorail is easily extended four feet beyond the shelter door acting as a cantilever beam. This is illustrated in Figure 14, operating at $-65^{\circ}F$ environment. It is also retractable for storage and can be quickly released and removed from the shelter through use of quick release pins. A ceiling track is a fixed design within most shelters and the monorail can be utilized interchangeably between other like shelters. Conceivably, only one monorail for several shelters need be provided. The principle of loading, as illustrated, is greatly simplified by the use of this loading means.

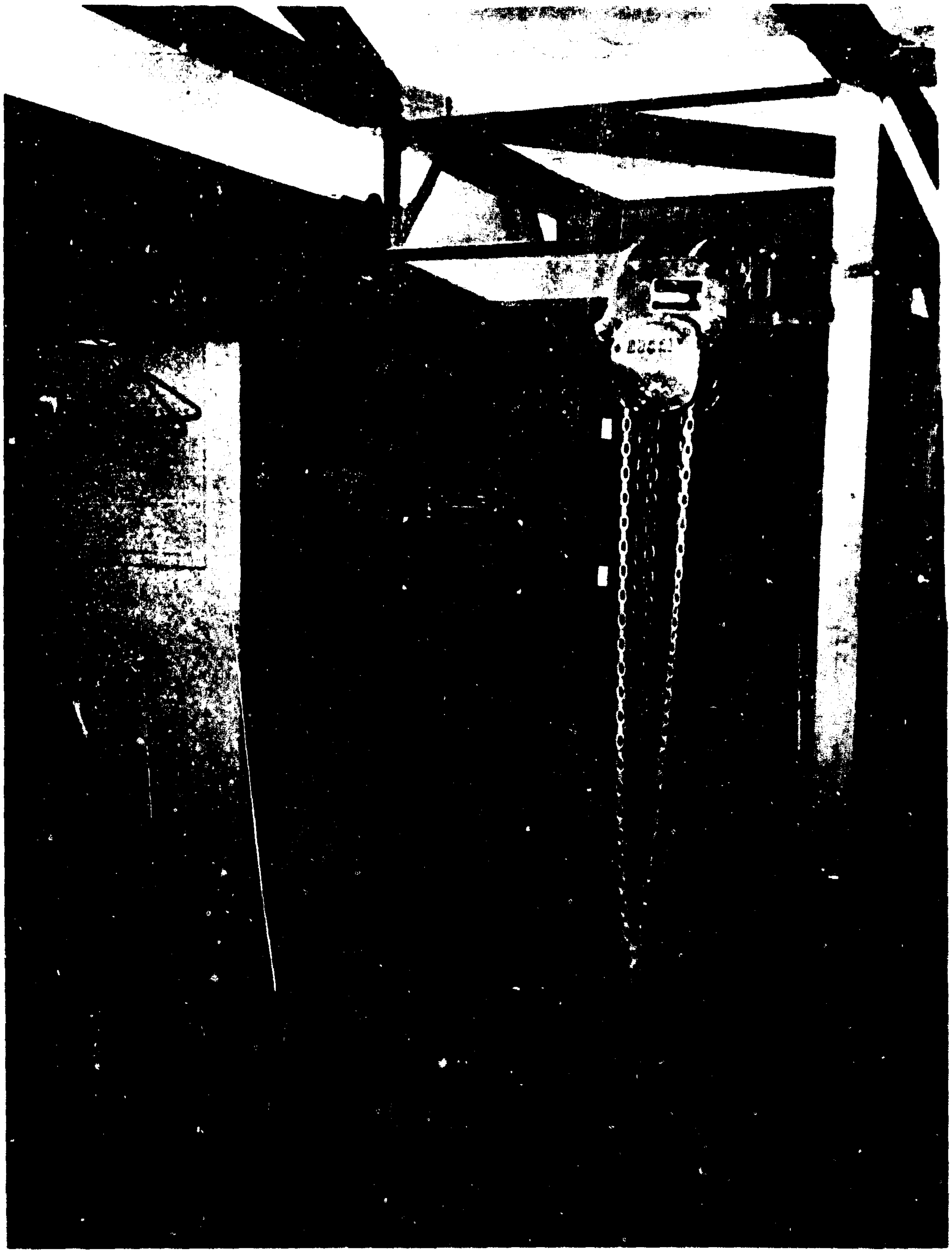

Figure 14. Monorail Extended

III POWER GENERATION

A. Introduction

The primary power needs for the system under consideration deploying many shelters can be met by employment of portable, compact, lightweight power sources of the gas-turbine-powered generator type. To minimize logistic support and improve maintainability the use of a single standardized unit should be adhered to as much as possible. Analysis of load requirements indicated that a 25 kva unit would satisfactorily meet the majority of power requirements of the shelters being considered. The full a. c. output rating of this generator is 25 kva, 0. 8 power factor, 120/208 volts, 3-phase, 4-wire, 400 cps. The turbine generator set selected is illustrated in Figure 15 and since it has already been used for other Air Force systems, it has been assigned FSN-6115-952-1539.

B. Requirements

In order to arrive at the final selection of the power unit described, particular characteristics to meet operational requirements were studied and the following criteria determined:

1. The unit was to be compact and as lightweight as possible.
2. Each shelter was to have its own interchangeable power package to increase reliability.
3. Noise level requirements were to be kept at minimum tolerable level.
4. Specified world-wide environmental requirements would have to be satisfied.
5. Maintenance to be kept at minimum level.
6. 400 cycle electrical equipment was to be used where possible.
7. Obtain off-shelf item if available.
8. Ease of mobility.
9. Fueling and supply aspects.

A survey of available generator sets was made and as a result of load analysis and combined systems analysis, the 25 kva turbine generator set was adopted.

C. Power Distribution

Power distribution concerned itself with many factors, such as mobility required, proximity of shelters to one another, deployment plan preferred, environmental considerations and logistics. Whether shelters were to operate singularly or as clusters had to be considered. In view of this, a central or semicentral system versus independent deployment of power units were evaluated. To meet reliability and single element operational

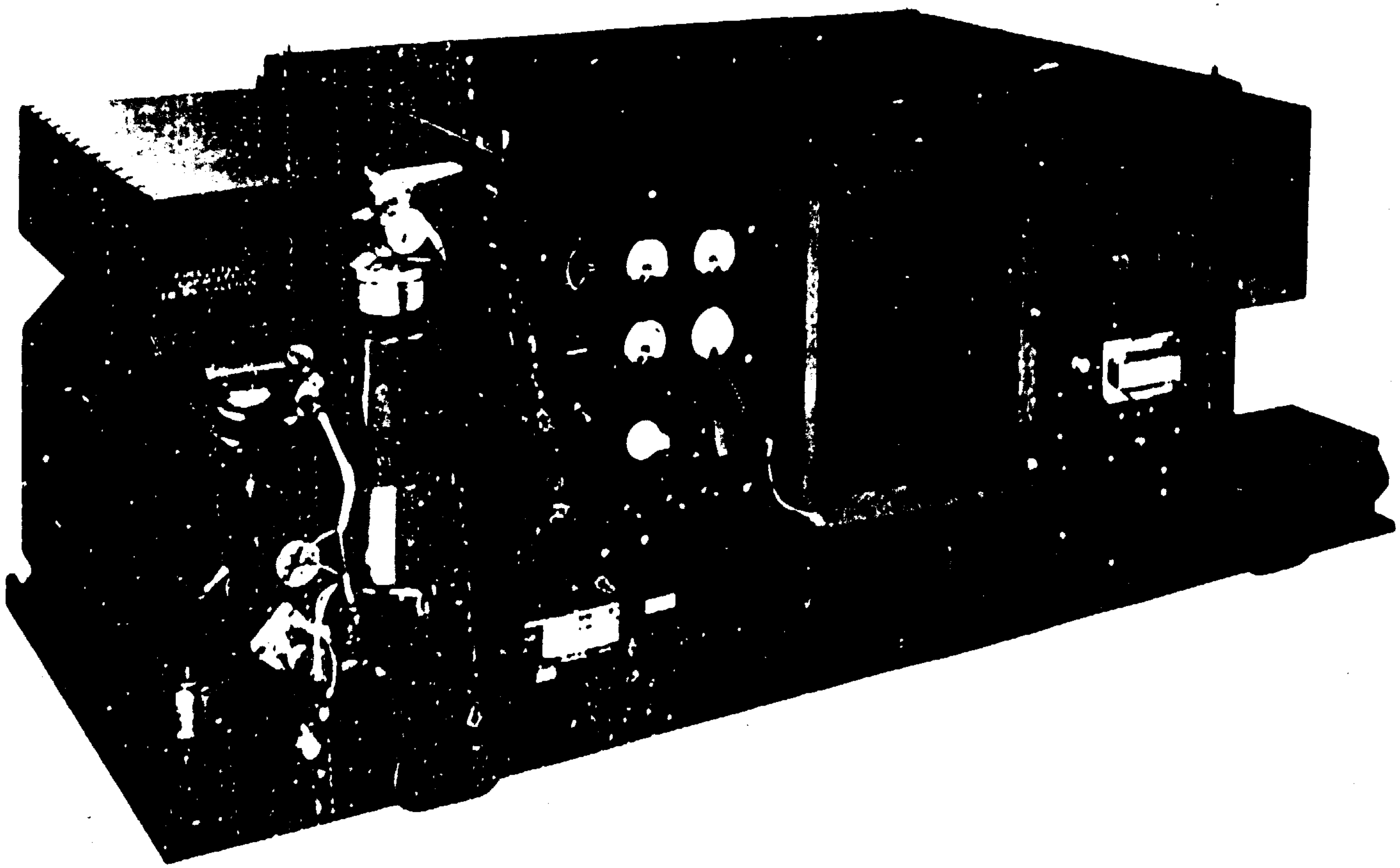

Figure 15. Gas Turbine Generator Set

deployment possibilities, power units of the 25 kva class for individual shelters appeared more promising. A breakdown of a large unit supplying power to several shelters would curtail a larger percentage of an on-the-air operation. A quick interchange of singular units would reduce down time. This criteria, it was felt, was more desirable.

Since most of the electro-optical equipment was designed for 400 cps power in view of weight and volume saving relationships, 400-cycle power generation was also desirable from the same standpoint.

D. Selection

Because of the mobility requirement of the Mobile Data Extraction System, it is also necessary to concern ourselves with weight and size of the power package. Noise levels and fuel consumption were also taken into account.

1. Weight - The dry weight of the power package is approximately 375 pounds, which can be towed or carried for short distances by four men. The units reflect an ease of handling capability. The comparatively low weight of this unit in the over-all equipment weight evaluation favored its use.

2. Size - The 25 kva gas turbine generator set is 60 inches long by 25 inches wide by 23 1/2 inches high, is completely self-contained with an incorporated 10-gallon fuel tank. This size was completely compatible for shipment installation with the shelters when in transit. The size indicated allowed for consideration of a practical packaging plan within functional shelters.

3. Fuel Consumption - One factor which was investigated was the high specific fuel consumption of these units. Approximately 9 gallons per hour of fuel is consumed at full load operation; however, since the system will be operable at or near air fields, it was determined that fuel availability will not be a major problem.

E. Location Considerations

In the evaluation of power generation equipment, numerous factors were given adequate consideration in deciding whether units be an integral part of a shelter or whether they be located exterior to the shelters. It was recommended that the power units be deployed exterior to the shelters. The governing factors dictating this choice were attributed to the possibility of increasing problems in noise suppression, vibration, toxic fumes, fuel and engine exhaust provisioning, shelter space limitations, logistics, and cost. External deployment of power packages has been previously examined in this text and the advantages listed far exceed the disadvantages of internal shelter installation.

F. Summary

The power unit selected was evaluated against available diesel and gasoline engines and exhibited a greater portion of the characteristics required for the Mobile Data Extraction System. It was found to be compact, light in weight, easily maneuverable and adaptable for use in the mobile concept under discussion. The unit is very easy to operate and will start at both extremes of temperatures; namely, -65°F. and +125°F.

IV ENVIRONMENTAL CONTROLLER

A. Selection and Characteristics

Selection of an environmental control unit is basically dependent on analysis of transmission and solar losses and internal loads made up of lights, motors, electronic equipment, plus other electrical loads together with ventilation requirements. Once an analysis is completed on an accurate determination of required capacities, a unit should be selected that would meet a majority of the many guide lines established. Most of the calculations for the various shelters in the complex indicated that 36,000 BTU/hr cooling and a 27,000 BTU/hr heating rate would not be exceeded. Investigation into the availability of all militarized environmental control units was undertaken with the following basic criteria determining selection:

1. To be rugged and reliable under conditions imposed through world-wide use.
2. Compact in size and suitable dimensionally for transit within the shelters.
3. Capable of possessing sufficient capacity to maintain internal ambient temperatures of 50°F. for winter and 90°F. summer for extreme limits of -65°F. and +125°F.
4. Power required to operate (400 cycles).

The environmental controller weighs approximately 250 pounds and is 26 inches in height, 36 inches in width and 26 inches in depth. Figure 16 illustrates the environmental controller which has a maximum power consumption of 8.5 kw. It has 3-ton cooling capacity and 18,400 BTU/hr heating capacity. Ventilating capacity is variable from 0 to 75 cfm. This unit was found to be in Air Force inventory under FSN-4120-050-8131. With minor modifications, it was decided that the unit would be adequate and would satisfactorily fulfill requirements. The modifications included the addition of remote control capability with a remote control switch assembly activating the three modes for venting, cooling and heating. A three-stage selector switch for heating was also added. The BTU/hr heating capacity of the unit was increased to 27,000 BTU/hr from 18,400 BTU/hr, having no less than three switching stages of heating, each stage yielding approximately one third of the total 27,000 BTU/hr capacity.

These adopted changes provided the system plan with a sound package which could be efficiently deployed. Figure 17 shows the packaging technique utilized when shipping the power and environmental control units. The environmental controller is shown atop the gas turbine generator set in its transportable state.

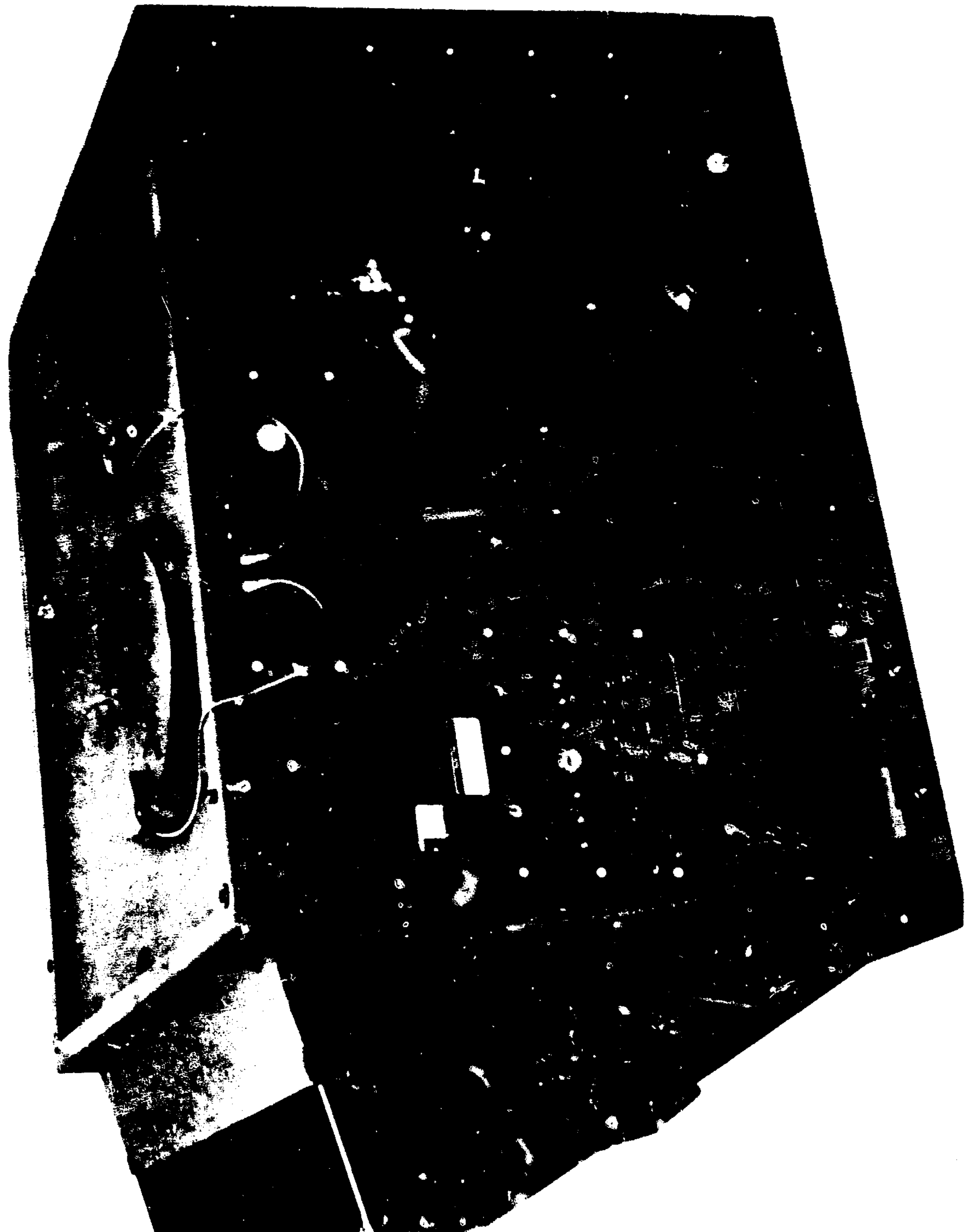

Figure 16. Environmental Controller

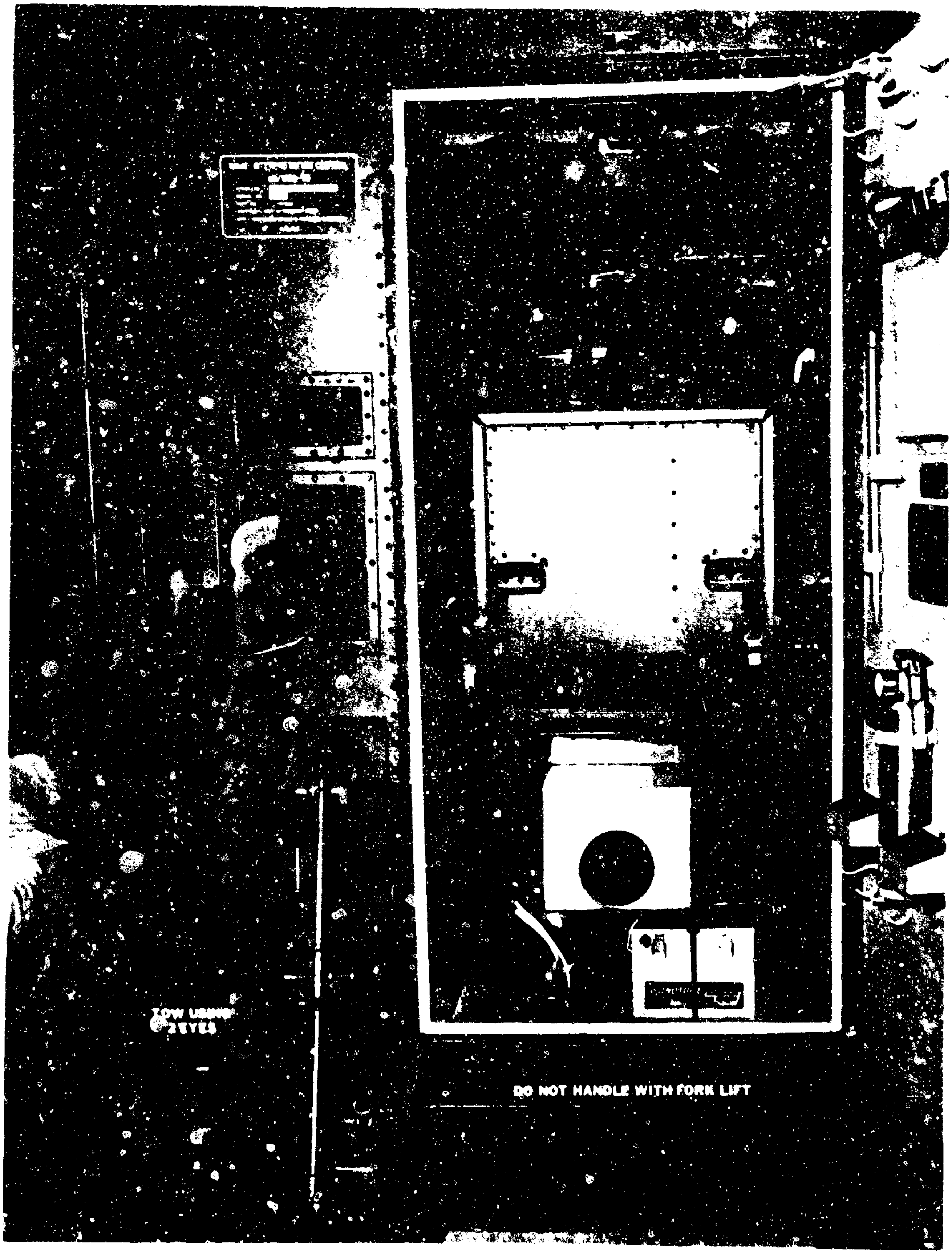

Figure 17. Turbine and Environmental Controller (Packaged)

B. Static Converter

In addition to the gas turbine driven 400-cycle generating system required for most of the electronic components, certain loads in the complex require 60-cycle power. These loads can be furnished by converting a portion of the basic three-phase, 400-cycle power from the gas turbine generator to single-phase, 60-cycle power through use of a solid state static converter. Another means would be to use the more conventional rotary 400-cycle to 60-cycle motor-generator sets.

Solid state static converters are essentially a recent development, their manufacture being limited to a few industrial concerns. They are not off-the-shelf items when compared to the numerous motor-generator sets available. Costs for static converters run high and available varied kw capacities are known to be limited. However, in considering their light weight, reliability, compactness, and noise reduction aspects, they offer favorable advantages. In this first prototype system analysis both types of conversion units were put to use in the individual modules requiring 60-cycle power. This will allow for evaluation of both type units when considering final possible system production changes. An illustration of both units is shown in Figure 18 and Figure 19. A 10 kw static converter is presently being evaluated.

C. Accessway Shelter in a Deployment Plan

1. Characteristics - In the evaluation for a system deployment concept utilizing shelters of the S-141( )/G type, it was apparent that an efficient layout plan was essential to arrive at a possible standard configuration. After considering several possible configurations, the deployment concept most suitable operationally as well as economically was conceived. Equipment packaging within the complex is included because of its intimate relationship with shelters and general mobility features demanded of tactical equipment.

A number of factors have been considered in the design of a satisfactory over-all shelter deployment system. The design parameters desired for incorporation into an optimum system considered the following necessary characteristics.

a. Effectivity - The design shall require a minimum of extra equipment and special provisions to effect the system layout. Ease of assembly and disassembly in the field shall be of utmost concern.

b. Flexibility - The design shall allow for easy expansion or reduction of the over-all shelter complement to allow for changing intelligence processing requirements. Also, the design shall provide a maximum flexibility in shelter orientation to fit a field situation.

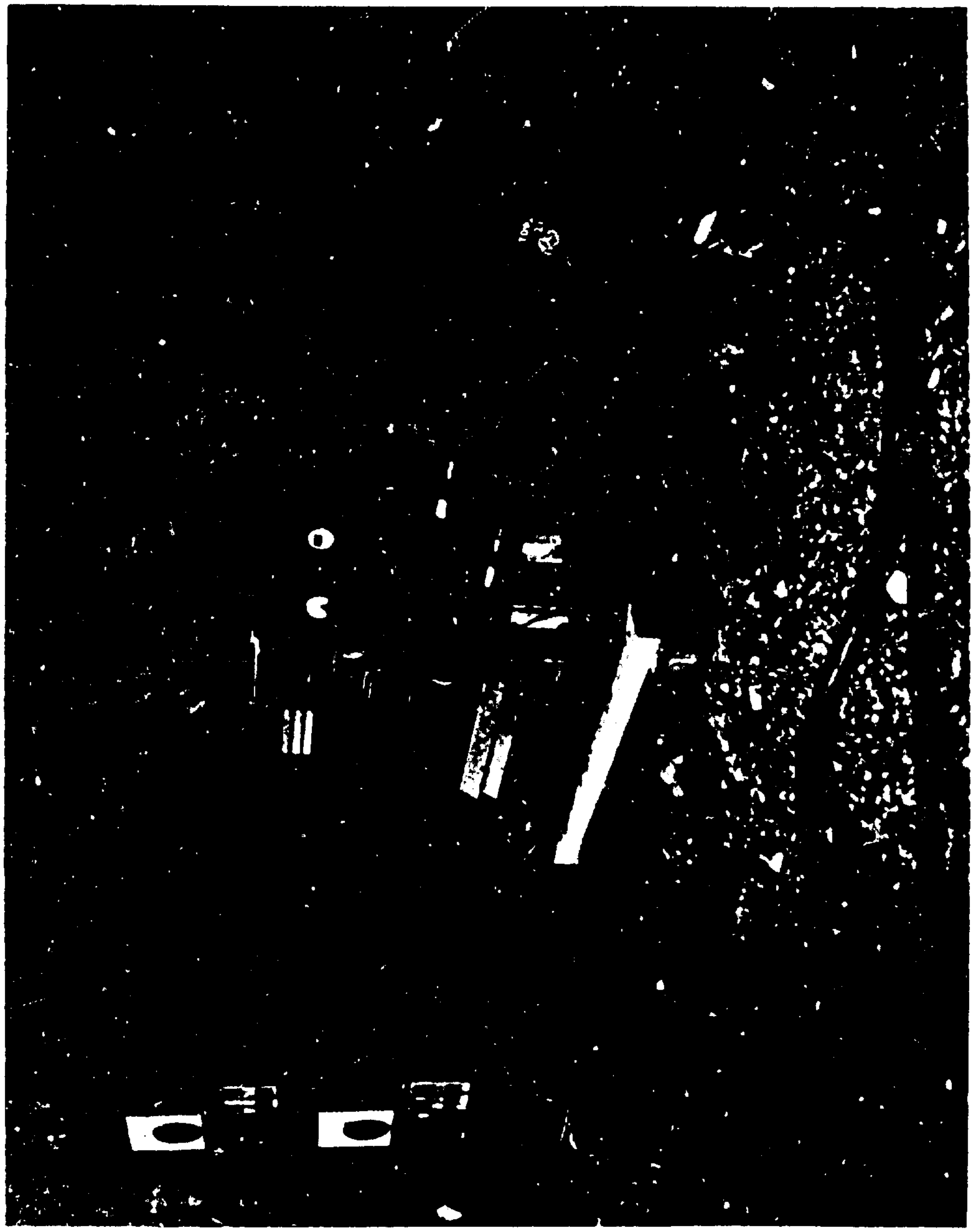

Figure 18. Solid State Static Converter (10 kw)

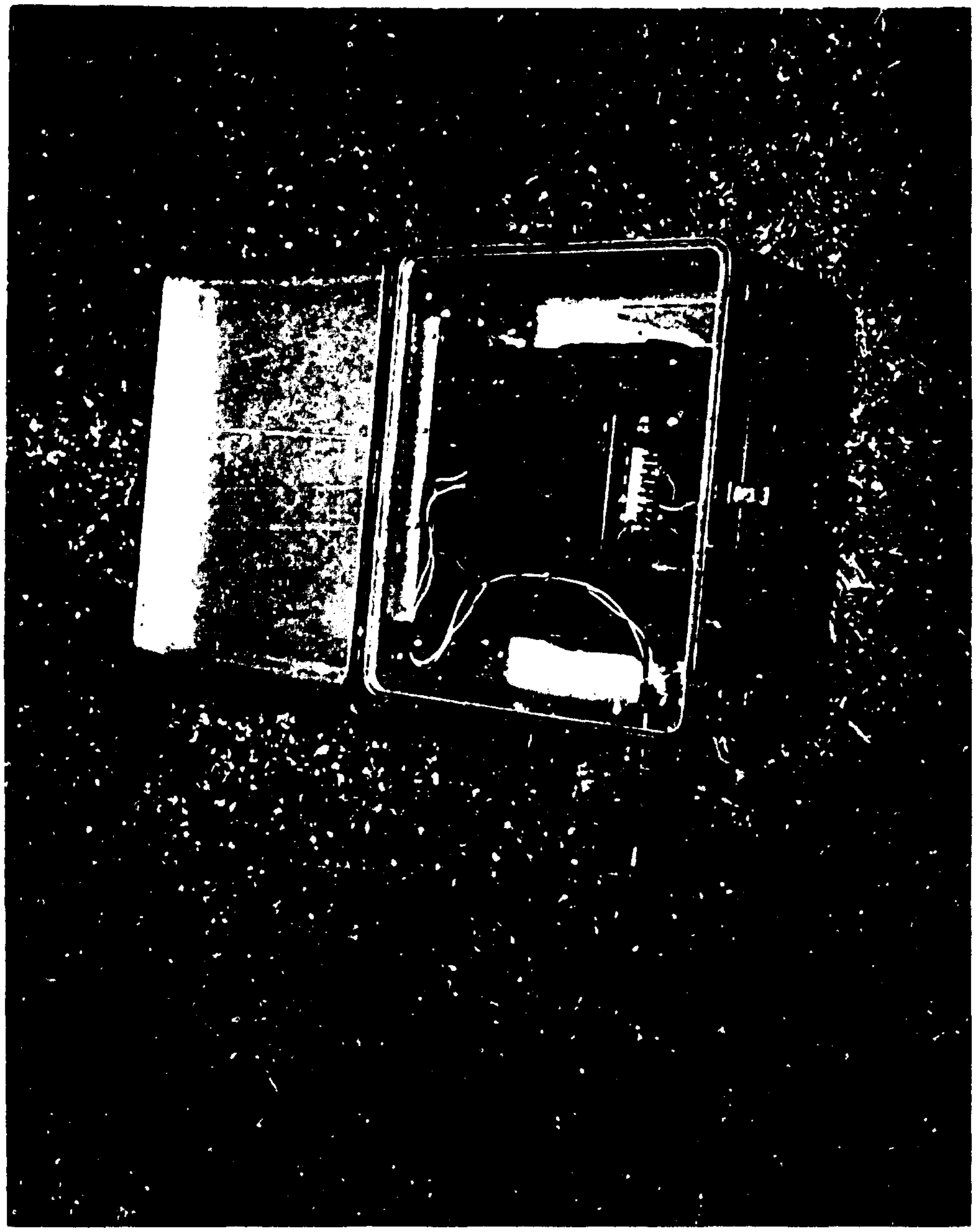

Figure 19. Motor Generator Set

c. Environmental Protection - A prime design criterion shall be the establishment of weatherproof passageways between those shelters requiring a continual transfer of personnel and physical data (film, hard-copy, etc.) in the operational situation.

d. Storage - The design shall allow space for storage of transit cases, special purpose tools, special protective covers, etc., during actual operation of the system. Present shelter designs indicate a definite need for systematic storage of these items to enhance the "neatness" of the deployment area and to prevent possible losses of equipment after "set-up".

e. Cabling - The design shall consider methods of minimizing interference with cable lengths and cable densities. As a design goal, all cable runs should be out of the way of personnel and vehicular traffic.

f. Gas Turbine Generator Units - These units must be located near the outer periphery of the system layout for maximum safety, ease of access, and noise reduction. The fuel delivery system for these units must also be located on the periphery for safety and accessibility.

g. Human Factors - The design shall consider such human related factors as:

1. Storage of outside gear, clothing, etc.
2. Rest Area.
3. Emergency exit ways.

As a result of the considerations given to these design factors, a deployment plan meeting most of the cited criteria above is herein presented.

2. Deployment Considerations

The plan essentially imposes a need for a number of basic S-141( )/G type "accessway shelters". These shelters, when properly deployed and set up, would provide maintenance areas, weatherproof personnel passageways, storage areas, and areas for personnel comfort needs. The evolvment of specific details have not been entertained in this discussion; however, it is felt that the general approach is entirely satisfactory. The basic accessway shelter referred to is essentially a nonshielded shelter requiring little or no provisions for power or environmental control. In essence, they act only as versatile "connecting assemblies" between functional modules. The sketches presented in Figures 20, 21, and 22 will best serve to illustrate the general design and deployment concept such as might be applicable for an operation site. It is not intended in this report to show specific functional shelters in an actual arrangement, but only to represent the prime philosophy behind the grouping desired and the means for effecting such groupings.

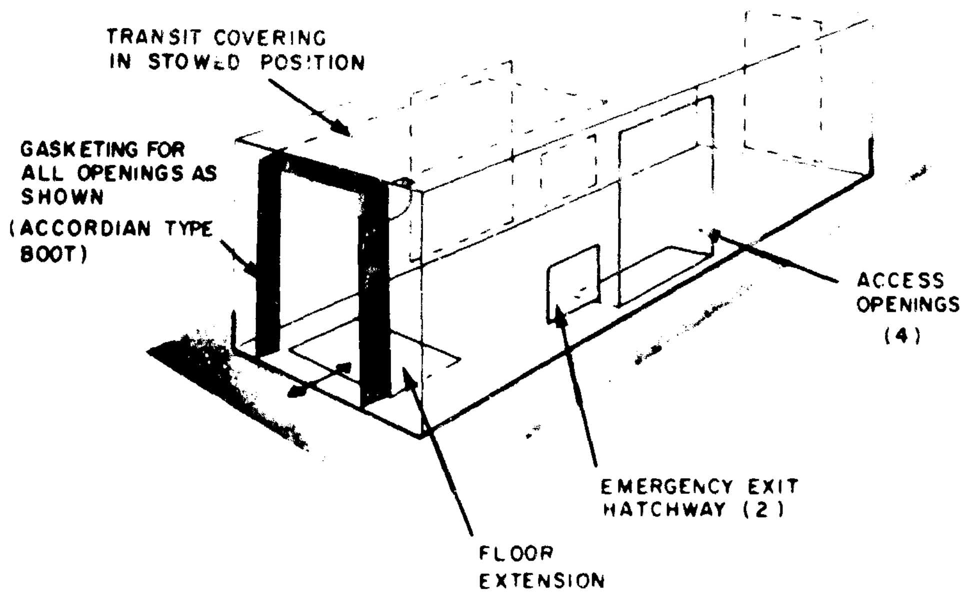

Figure 20. Basic Accessway Shelter

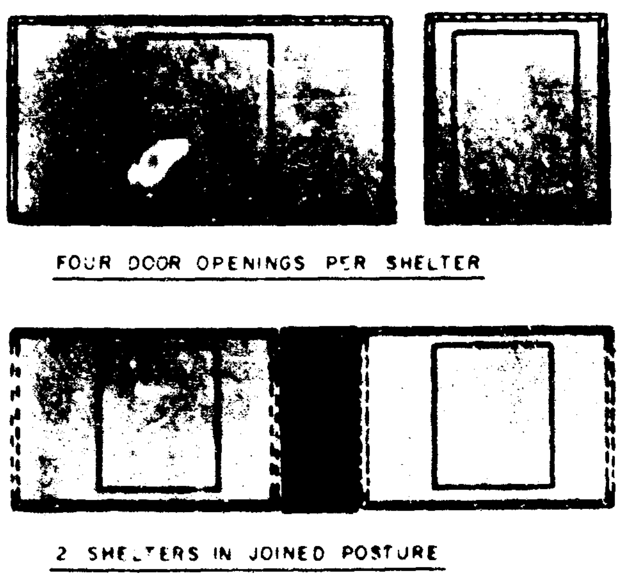

Figure 21. Joined Accessway Shelters - Basic Element in Deployment Plan (Basic S-141) Structure

Briefly, a basic shelter would contain four openings--one at each wall surface so that it would be capable of accepting a number of shelters positioned within a few feet of itself. The openings, with doors, shall be larger than the standard functional shelter door sizes. Preferably, an accordian type boot shall be affixed around the outer vicinity of the opening. This boot, when extended, shall couple with adjoining shelters to form a weatherproof enclosure between themselves. When secured in this position, the doors of the functional modules can be opened outward and access to the connecting modules can then take place. Interconnecting or accessway modules can be placed end to end as shown. The sketches show the possible end wall to end wall connection. The accessway modules offer a basic building block system, allowing for a definite grouping of shelters. It should be noted that positioning of the power and environmental control units are external and away from the heart of the complex; yet, they can be located within efficient distance of the work area. The fuel supply, also on the periphery of the complex, can consist of large capacity rigid or flexible tanks, each independently supplying a number of power units. These central fuel tanks can be refueled with a minimum possibility of fuel trucks running over fuel lines. Entry into these shelters prior to entry into the functional modules eliminates the tracking of mud and dust into equipment area. Entry of undesirable foreign matter into critical electro-optical equipment areas could be damaging to existing high cost hardware. Nearly total elimination of such matter into the functional units is effected by use of the accessway shelters.

Precise alignment or positioning of the shelters in all cases for such a deployed system is accomplished readily with the use of combination jack and caster assembly dolly previously discussed, allowing any shelter to be easily added or removed from the complex.

The added integral feature of leveling on these dollies is readily seen when slight ground undulations exist.

The accessway shelters, besides acting as passageways between modules, can also be used to perform several other functions, if required. For example, they can be designed so that they may carry excess cables, ducts, etc. In one respect, they can be useful in the sense that they can also be considered as large carrying or transit cases. Tie-down provisions can be incorporated throughout the shelters for this purpose. Utilization of these shelters for this purpose, and storage as well, could be an answer to alleviating possible congested conditions in functional modules.

V. OVER-ALL SUMMARY

To summarize, the following features are represented through this type standardized system of deployment:

a. Affords means for a compact, balanced, deployable system.

b. Standard accessway shelters as rigid enclosures, act as passageways and storage rooms, provide accessibility between system modules, provide areas for comfort needs, and act as entry ports prior to entering any individual module.

c. Allows for good layout scheme for power packages and provides protected areas for cable layout. Cable lengths are minimized. Cable runs do not interfere with personnel moving about the operational area and the shorter lengths reduce costs and improve efficiency.

d. For future considerations, this deployment plan lends itself to utilization of larger capacity environmental control units within these modules reducing external duct runs and possibly, the number of units required.

e. Combined shelter units can be added to the system as shown in the over-all plan view.

f. Modules can be added or taken away at any time without interfering with other operational modules.

g. Inter-communications wiring between modules is reduced. The illustration depicting the possible deployment plan is illustrated in Figure 22. It is believed that the deployment scheme discussed herein will invite further thought toward establishment of a standard system package useful for most systems with similar requirements.

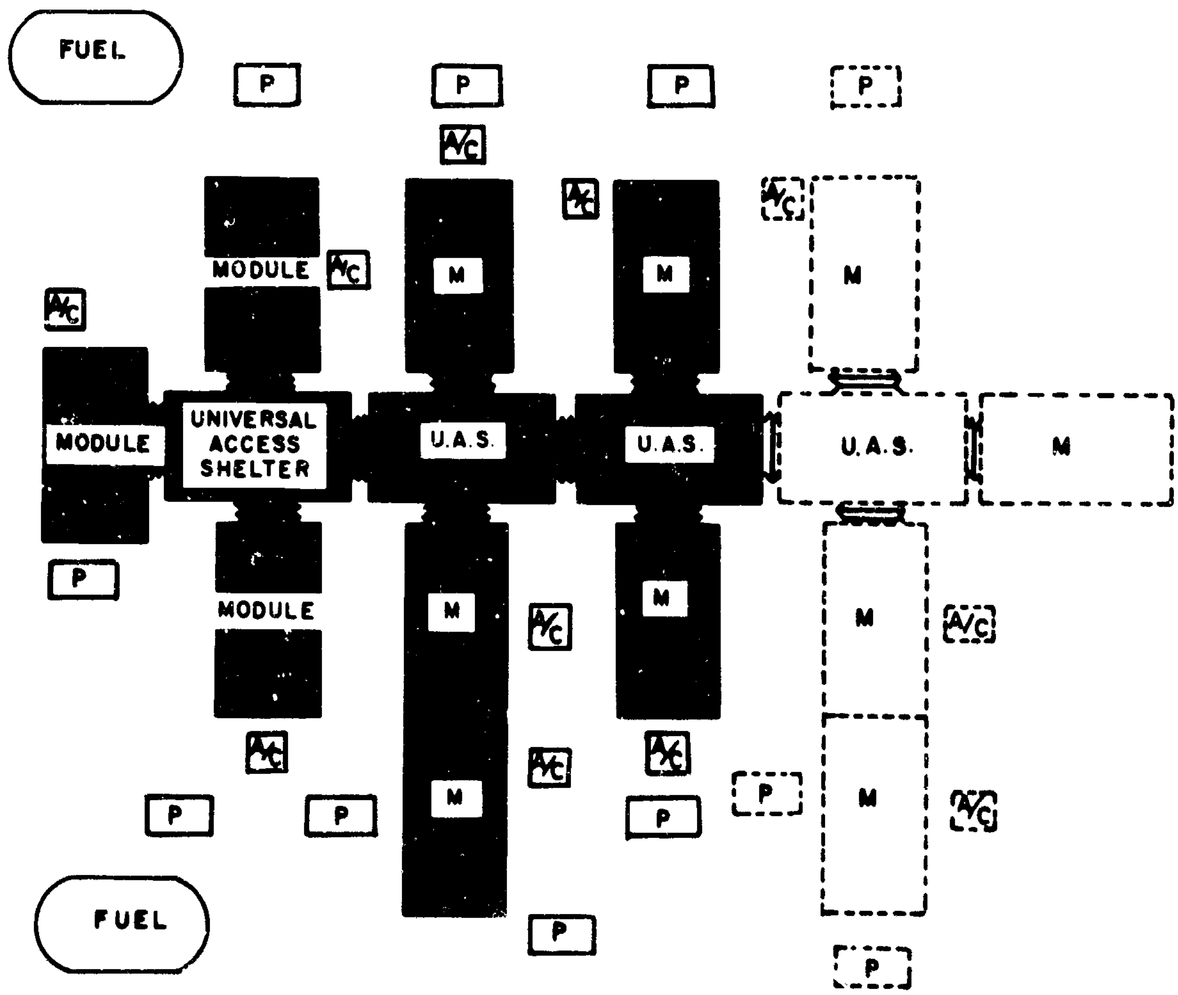

Figure 22. Deployment Plan

APPENDIX

Transporter Technical Characteristics

The technical characteristics associated with the design of the transporter are enumerated below. The design is in fact a simple configuration utilizing off-the-shelf wheels with a known jacking technique.

1. Jack - The jack is a rugged screw type device having a maximum travel of 14 inches. It is equipped with a 10 inch long ratchet-type, removable elevating handle. The wheel supporting strut is an aluminum tube (6061-T6) which functions as a jack through a worm gear driving a rack and pinion mechanism. The rack is secured to the aluminum tube and is driven through the gear box when actuated by the ratchet wrench. Each jack has a capability of lifting 3100 pounds.

2. Caster Wheel - The caster wheel, providing 360-degree swiveling, is equipped with a 21 3/8 inch outside diameter pneumatic 600 x 9 tire. The large wheel size enables four men to push the shelter payload field type over unpaved terrain. The caster wheel is equipped with a five-position, 45 degree swivel lock strut arm which is capable of pivoting and locking either side of center in increments of 45 degrees, plus or minus 2 degrees, for a total of 180 degrees, plus or minus 5 degrees. The caster wheel and jack assembly, when retracted, gives one inch clearance between the tire and ground level.

3. Brakes - Each jack and caster wheel assembly is equipped with a friction brake which is activated by depressing a handle at the top of the caster wheel assembly. Depression of the handle brings a serrated friction plate firmly against the outer surface of the tire. The brake is manually released by pulling up on the handle, retraction being assisted by a loaded spring mechanism.

4. Tow Bar - A folding steel tow bar and pintle is provided for rapid attachment to the shelter towing eyes. The weight of this unit is approximately 40 pounds. Towing can be accomplished by M-35 truck or other prime mover having a suitable pintle arrangement to fit the tow bar. Attachment or detachment of the tow bar rig requires use of ordinary mechanic's hand tools.

5. Dimensions - The over-all dimensions of each jack and caster wheel assembly are approximately 46" x 22" x 18".

6. Weight - The weight breakdown for each complete jack and caster assembly is as follows:

Item Description	Weight in Lbs.
Caster wheel assembly w/aluminum rim	108.0
Shelter adapter casting	33.0
Jack post housing and gear assembly and radial arm strut	40.0
Jack strut w/rack drive and cover plate	35.0
Pivot bolts, tie handle and environment boot	9.5
Ratchet crank drive	5.0
Total Weight	230.5 lbs.

This unit being the first prototype may be further reduced in weight through use of aluminum in the caster wheel assembly, since the present wheels utilize a standard steel vendor production part.

7. Mounting Provisions - The shelter caster wheel assemblies are mounted onto steel mounting pads which are installed on the shelter side walls. Eight bolts firmly secure the assembly to the payload requiring an ordinary wrench for installation.

8. Aircraft Loading - The shelter, together with the jack and caster assemblies, may be readily loaded aboard a C-130 aircraft. Loading of the modified S-141 shelter assemblage, together with its jack and caster units, has been worked out for a C-130 aircraft. At the worst condition of the loading ramp, there is adequate clearance between roof line of the aircraft and roof of the shelter. Sufficient clearance is also provided between the ramp crest and shelter skids. This is achieved by raising and lowering the front and rear jack and caster assemblies, as dictated by the loading and unloading requirements. The maximum width of the shelter, together with its jack and caster assembly, is 112 inches. The track width is 104 inches.

9. Service Life - The transporter is constructed for a minimum service life expectancy of five years with normal maintenance.

10. Climatic Extremes - The transporter is capable of operating under the extreme climatic conditions specified by MIL-E-4158.

11. Materials - In general, materials for the design application were selected to conform to applicable portions of MIL-S-8512.

Summary

The combination lifting and positioning transporter provides a means of moving an S-141 type shelter over unimproved terrain for short distances. It also provides a most important feature in that it permits precise positioning of the payload. When consideration is given to any type of joining philosophy, precise positioning in both the vertical and lateral planes is essential. With this capability operational system layout is simplified and can be deployed in a compact configuration. Other known type wheels existing and in use today have some restrictions in regard to turning radii which limit set-up mobility.

The transporter, as a first prototype, also permits payloads to be raised from the ground to a maximum height of 12 3/4 inches for limited cross-country, and runway travel. The shelter may thus be raised to its maximum height or be lowered through various increments to ground level. In a raised position, cables may be run between and underneath shelters, thus reducing cable lengths and weight for a well planned fixed system.

The mechanical parking brakes equipped with each wheel prevent shelter movement when positioning on a grade.

The transporter, together with its mounting adapter, may be readily retrofitted on a wide variety of packages within the design weight limitation for greater versatility.

This transporter, when attached near the ends of sidewall panels, does not interfere with the end walls, leaving shelter and wall attachment design free of obstruction.

The design of the transporter, including the two-position function, allows for transportation of the transporter and shelter within a C-130. Since the attachment is made at the sidewalls, valuable linear space is preserved within the aircraft.

It is felt that for low speed, short distance travel, this transporter is well adapted to various possible system deployment plans. It will move, raise and lower a payload in any desired direction.

The simplicity of construction of the wheel assembly is represented by Figures I-1 through I-4 showing the following:

1. Radial arm strut
2. Shelter adapter casting
3. Jack tube support casting (gear box)
4. Boot
5. Sleeve bearings
6. Bolts
7. Two cover plates
8. Rack, pinion, worm and worm gear drive
9. Wheel (pneumatic)

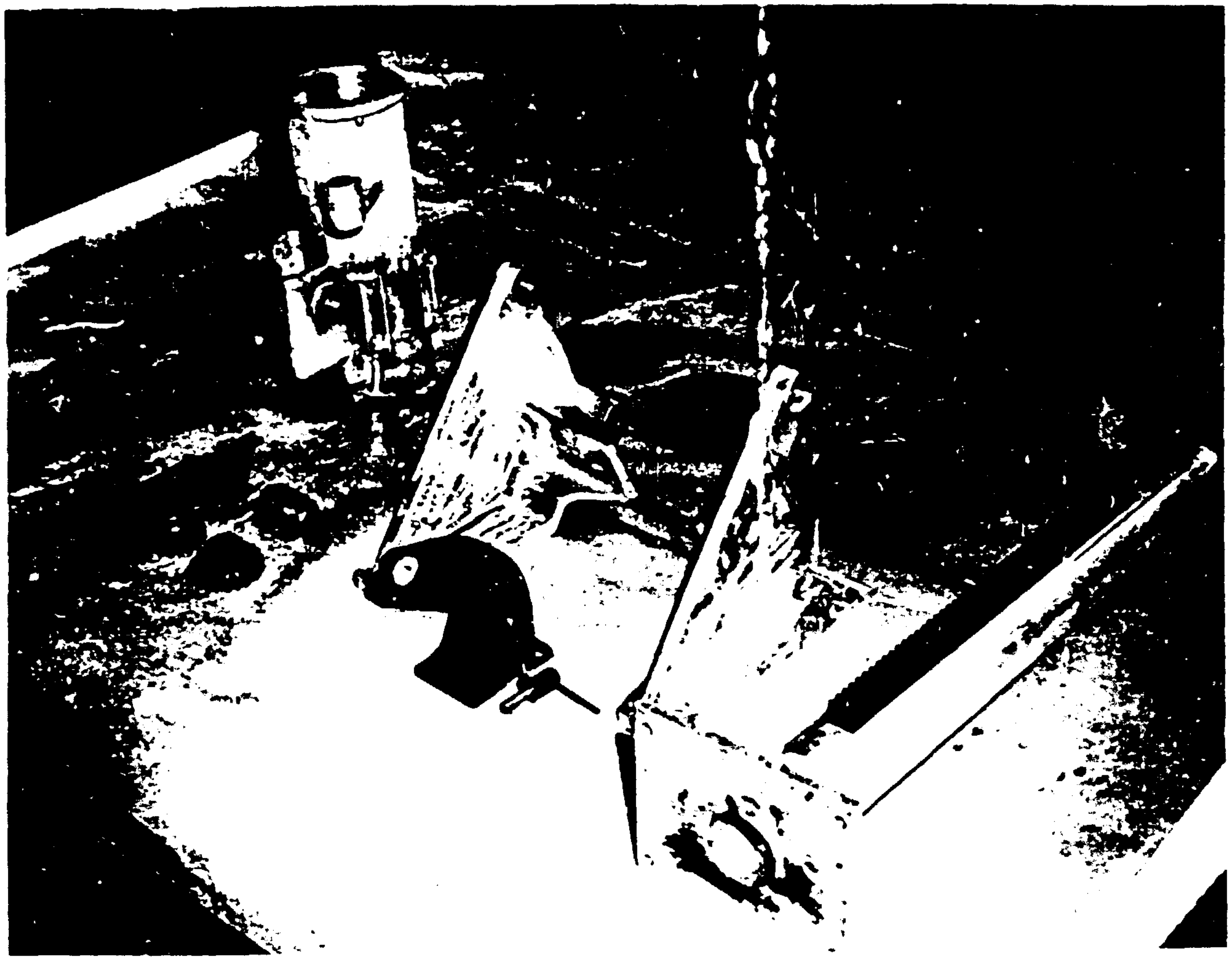

Figure I-1. Major Wheel Ccmponents

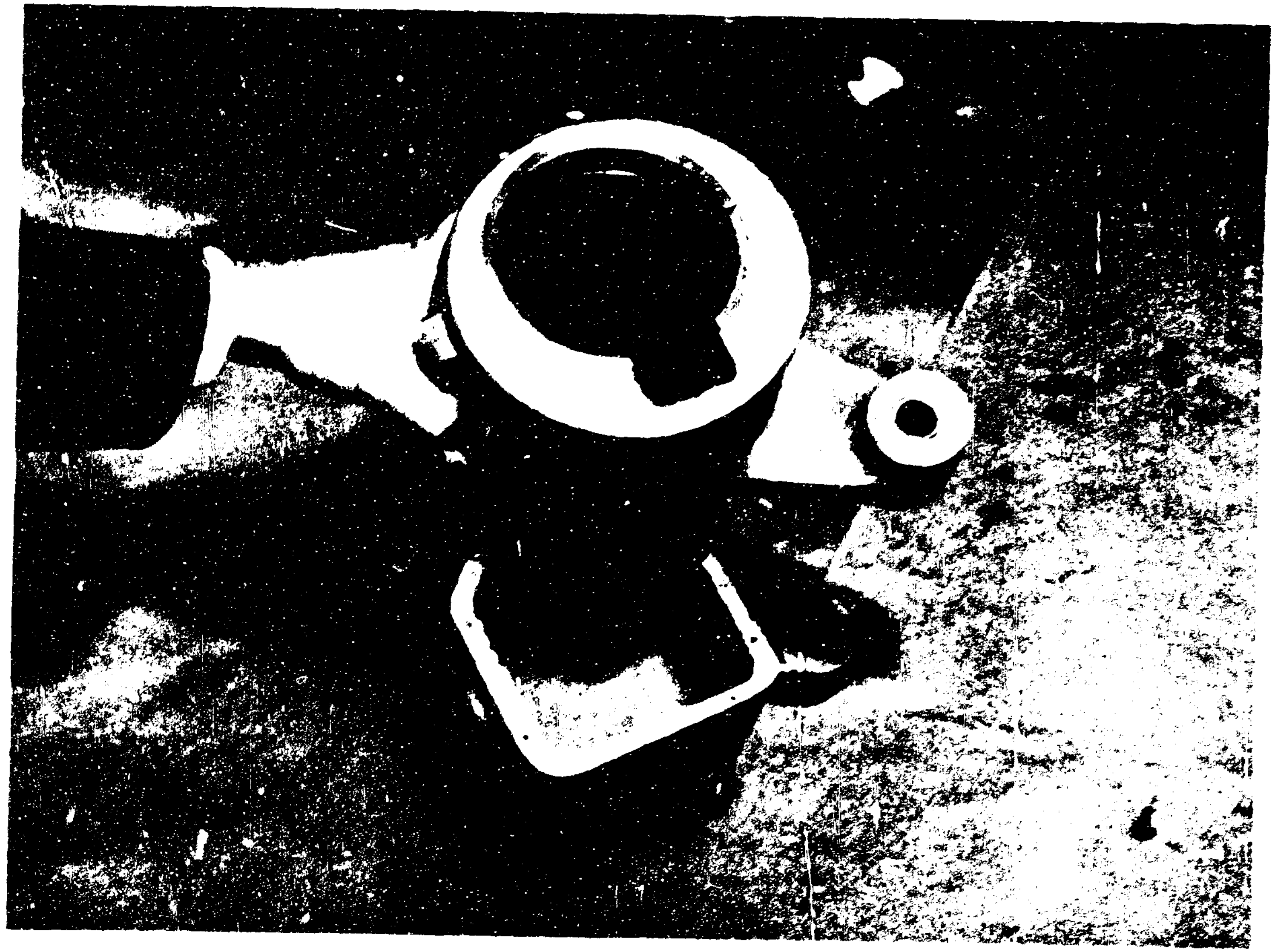

Figure I-2. Jack Tube Support Casting and Gear Box

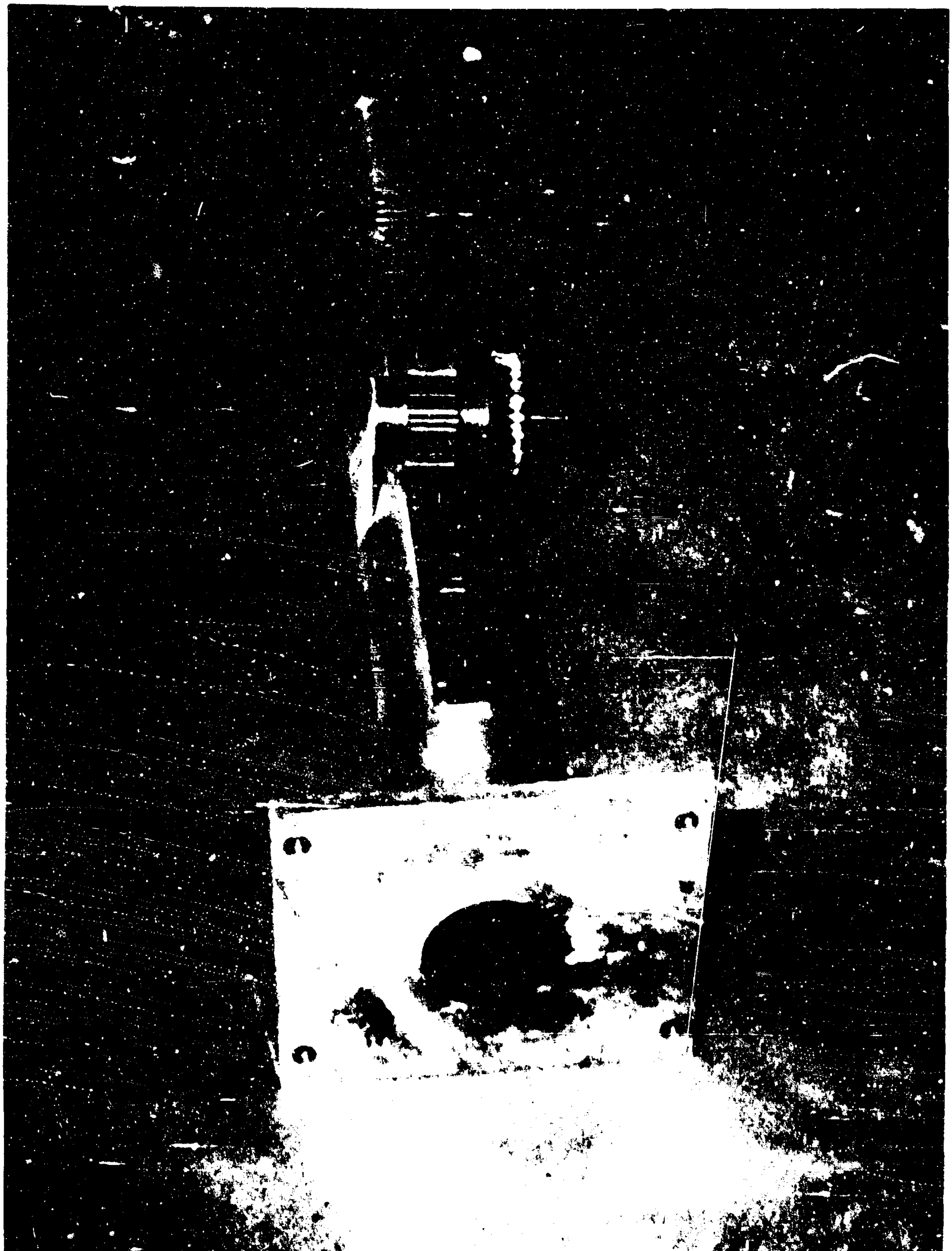

Figure I-3. Rack, Pinion, Woım and Worm Gear

Figure I-4. Pneumatic Wheel Assembly

The following operations were timed and recorded during preliminary tests:

1. Fully extended position to ground level -------- 1 min 12 sec
2. Raised from ground to fully extended position -- 3 min 55 sec
3. Removal of wheel assembly ------------------ 2 min 15 sec
4. Attachment of wheel assembly ---------------- 4 min

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13. ABSTRACT

This report contains an analysis of factors to be considered in the selection of shelters, power, air conditioning, and transporters relative to efficiency in the attainment of over-all mobility. The evaluations presented herein involved ensuring the best and most timely use of existing technologies. Selection of what was considered to be optimum choices in unit equipments was then integrated to evolve a standard plan for deployment.

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